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Records of the Government of India,

HOME DEPARTMENT.

No. LXIV.

REPORTS

ON THE

COAL RESOURCES AND PRODUCTION OF INDIA.

Published by Authority.

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COAL RESOURCES AND PRODUCTION OF INDIA.

From the Secretary of State for India, to the Government of India,—No. 29, dated 24th March 1866.

A collection of papers has been lately laid before Parliament, being reports from Her Majesty's Missions abroad on the coal production of foreign countries; and it is now the intention of Her Majesty's Government to instruct the Queen's representatives to report further on this subject, in order that their reports may be laid before Parliament in 1867.

2. I have to request, therefore, that you will issue directions to your Officers in the several districts of your Presidency, to furnish reports on the coal resources and production in the districts under their charge, supplemental to the report by Dr. M'Clelland of the 11th July 1845.

No. 876—883.

Copy forwarded to the Governments of Bengal, N. W. Provinces and Punjab, Chief Commissioners of Oudh, Central Provinces and British Burmah, Resident at Hyderabad, and to the Superintendent of the Geological Survey, with a request that the required report may be prepared and submitted to this Department for transmission to the Secretary of State.

No. 884, dated 15th May 1866.

Endorsed by the HOME DEPARTMENT.

Copy forwarded to the Public Works Department, with a request for any information on the subject which that Department may be able to supply.

From the Government of India, to the Secretary of State for India,—No. 101, *dated 3rd June* 1867.

On receipt of Lord de Grey's despatch No. 29, dated the 24th March 1866, we requested the several Local Governments and Administrations to furnish the reports required on the coal resources and production in the districts under their charge, and we addressed a similar requisition to the Superintendent of the Geological Survey, and to the Public Works Department.

2. We now transmit to you copies of the replies which we have received to our circular, together with twenty-five copies of a pamphlet on "the coal resources and production of India," prepared by Dr. Oldham with reference to Lord de Grey's despatch above mentioned.

From Bengal, No. 2722, dated 2nd October 1866.
From North-Western Provinces, No. 2RC., dated 21st January 1867.
From Punjab, No. 1627, dated 4th August 1866.
From Oudh, No. 2410, dated 26th June 1866.
From Central Provinces, No. 2008.151, dated 29th October 1866.
From British Burmah, No. 303, dated 20th September 1866.
From Resident at Hyderabad, No. 35, dated 9th August 1866.
Correspondence regarding Kurhurballee Coal Field (received under docket from Public Works Department, No. 507C., dated 8th June 1866.)

3. We may state that we are at present in communication with the Officiating Superintendent of the Geological Survey on the propriety of organizing some proper system of obtaining correct mineral statistics in India, and that we shall address you hereafter on the subject.

From T. OLDHAM, ESQUIRE, LL. D., *Superintendent of the Geological Survey of India, to the Officiating Junior Secretary to the Government of Bengal,—No.* 518, *dated* 24*th September* 1866.

Your letter No. 2135T, dated the 12th instant.

The report on the coal resources and production of India (including of course Bengal) was called for several months since by the Government of India, as well as the Governments of Madras and Bombay, and will be submitted in due course as soon after the close of the present coal year—generally supposed to terminate in October—as will admit of the returns of the year's out-turn being received.

No. 2722, dated 2nd October 1866.

Endorsed by the Government of Bengal.

Copy forwarded to the Secretary to the Government of India, in the Home Department, for information, with reference to the memorandum from his Office, No. 876, dated the 15th May last.

From LIEUTENANT-COLONEL C. J. HODGSON, R. E., *Officiating Secretary to the Government of the North-Western Provinces in the Public Works Department, to the Secretary to the Government of India* HOME DEPARTMENT,—*No.* 2*RC, dated Camp Agra,* 21*st January* 1867.

With reference to Mr. Under Secretary Howell's endorsement No. 877, dated 15th May last, on the subject of coal resources and production in the North-Western Provinces, I am desired to state that coal is not known to exist in any part of the North-Western Provinces, and that there is apparently not the least probability of its so existing.

2. I am to add that the printed Proceedings* of this Government, in the Volumes for April 1864 and August and September 1865 (Railway Branch), are the only ones which refer to the supply of coal to the Railway at Mirzapore from the mines at Rewah.

* With the Government of India, in the Public Works Department.

From T. H. THORNTON, ESQ., *Secretary to the Government of Punjab, to the Secretary to the Government of India* HOME DEPARTMENT, *Simla,—No.* 1627, *dated Murree, 4th August* 1866.

In reply to your letter No. 878, dated 15th May last, I am directed to submit copies of a memorandum, and its enclosures, from the Secretary to this Government, in the Public Works Department, on coal operations in the Punjab.

2. This memorandum may be considered as supplementary to Dr. Oldham's printed report, dated 30th April 1864, which contains, in fact, up to date, all the information this Government possesses in regard to the coal mines. The impression he derived from the brief inspection, which alone it was in his power to effect, was that the quantity practically available would probably not prove large. But, so far as the mines have been yet worked, there has apparently been no indication of exhaustion; and the experience thus gained appears to have led those engaged in the work to anticipate that the available supply may ultimately prove to be more considerable than at first seemed likely. The character of the coal does not entitle it to rank high as a coal for manufacturing purposes, being so liable to spontaneous ignition that its use in steamers is deemed to be dangerous, but it can evidently be turned to good account in railways.

3. The Lieutenant Governor has understood from Dr. Oldham that he hopes next season to be able to have a complete survey made of the Salt Range; and if so, it may be hoped shortly to obtain very complete information in regard to the coal deposits. These appear also to exist in some other portions of the hill ranges on the north and east of the Punjab; but, so far as is known, not in sufficient quantities to be practically of economic use.

From COLONEL A. TAYLOR, *Officiating Secretary to the Government of Punjab, Public Works Department, to the Secretary to the Government of Punjab,— No.* 1824, *dated* 21*st July* 1866.

In reply to No. 1243, dated 2nd June, the undersigned is desired to forward the accompanying memorandum on coal operations in the Punjab.

Memorandum by the Secretary to the Government of Punjab Public Works Department, on coal operations in the Punjab.

EXCAVATION OF COAL SALT RANGE.

The late Lieutenant-Governor, Sir Robert Montgomery, in a minute dated 17th July 1863, stated that his attention had been called to the existence of lignite or coal in the Salt Range, upon which Dr. Fleming had remarked very fully in his report published in the Journal of the Asiatic Society of Bengal, Vol. XXII. of 1853.

The coal had been examined and tried on several occasions, and once by Mr. Brunton, Chief Engineer of the Punjab Railway, who reported favorably of it; but no attempt had been made to systematically work the mines up to the date of Sir Robert Montgomery's minute above referred to.

In that minute orders were given that the matter should be taken up in earnest; and the question of the existence of coal or lignite fit for fuel be thoroughly tested and decided on, both in the Salt Range and at Kalabagh; and extracts from Dr. Fleming's report were sent for the information of the officers concerned.

A favorable report on the prospects of a coal field near Kalabagh and in the Bunnoo district was subsequently received from the Deputy Commissioner, but this was followed up by no further active measures. There is, however, reason to believe that the quantity available in these localities is very limited.

The excavation of coal was commenced in the Salt Range of the Shahpore district early in 1864.

Some of the coal obtained from two of the mines (Dhumdole and Mukruth) was sent to the Railway Authorities at Lahore for trial in their locomotive engines, and the result was favorably reported in the letters from the Chief Engineer and Locomotive Superintendent, published in pages 307 and 308 of the Supplement to the *Gazette of India*, dated 3rd September 1864.

The result of further trials, with a review of past operations, past expenditure, and the general prospects of the mines, were given in a memorandum published as a Supplement to the *Punjab Gazette* of the 12th October 1864.

In the meantime, Dr. Oldham, Superintendent of the Geological Survey of India, who had been ordered to proceed to the Punjab for the purpose in Government of India's letter No. 1116 of the 17th February 1864, had examined the mines, and reported on them to the Government of India. His opinions were not communicated to this Government; but in reply to a reference made in the Railway Branch, the Government of India, in letter No. 460R of the 16th August 1864, to the Under Secretary, remarked that, from Dr. Oldham's Report, the supply of coal seems very limited, and doubts are expressed as to whether it would be more economical than wood; and they require information as to the cost of the coal, when brought to the place where it can be usefully employed, compared with that of wood.

On this point full information has not been received; but enclosed is a report by the Acting Agent Punjab Railway, dated 11th January 1865, giving the results of experiments by the Locomotive Superintendent, from which it appears that the coal is an efficient fuel for Railway purposes, but that, if it be used alone, it is considerably more costly than wood, at the price at which that article could then be obtained. It will be observed, however, that, when wood and coal were mixed together, more perfect combustion was obtained at a cost of only 25 per cent. in excess of that of wood; and that it was expected that, by using a large proportion of wood, further economy would be effected. In these calculations the cost of coal at Mooltan is taken at Rs. 72-4 per 100 maunds, but the reduction of rate has been effected, and it may now be assumed at Rs. 68 per 100 maunds at Mooltan, of which the detail is as follows :—

	Rs.
Quarrying	16
Carriage to river	19
Carriage by river to Mooltan	31
Contingencies	2
Total ...	68

The quantity of coal supplied up to the end of the past year amounts to 47,667 maunds, at a total cost of Rs. 38,707 including carriage.

The mining hitherto executed does not help to the formation of a better estimate, than was previously practicable, of the quantity of coal the Salt Range can furnish. In a geological sense it is, there is ample reason to be concluded, strictly limited. But, on the other hand, the actual number of tons of coal that it can furnish is no doubt very considerable, and it is to be anticipated that some years hence, when the price of wood fuel has greatly risen all over the Northern Punjab, as it will undoubtedly do, the demand on these coal deposits of the Salt Range will be great, and that they will be able to meet it for a sufficient length of time to admit of arrangements for the re-production of timber being carefully and efficiently made.

From the Acting Agent Punjab Railway, to the Consulting Engineer to the Government of Punjab Railway,—No. 49, dated 11th January 1865.

I have the honor to acknowledge the receipt of your No. 42—7 of the 9th instant, and previous letters, on the subject of the employment of coal for Railway fuel.

2. I regret the unavoidable delay that has occurred on my part in answering your communications; I was unable to do so, with any exactness, without first obtaining the views of the Chief Engineer, the Locomotive Superintendent, and the Store-keeper.

3. The questions to be considered are—Whether coal is an efficient fuel for Railway purposes; and *secondly*, whether it can compete in price with wood fuel.

4. The first question has already been considered by the Locomotive Superintendent in the affirmative; and with regard to the second, it is shown, by actual experiment, that the consumption of coal is 40lbs. per train mile against 66lbs. of wood for 1,000 miles. The comparative consumption and costs of the two fuels would be—

		Rs.	A.	P.
Wood, Mds. 804-35, at Rs. 21-0-0 ...	...	163	3	0
Coal, „ 487-32, „ 72-4-0 ...	...	351	13	0

or an excess of 109 per cent. in the cost of coal over wood if used separately. But the Locomotive Superintendent reports that, if one-third of wood be mixed with the coal, the result is a more perfect combustion combined with a considerable saving in the quantity consumed, being only 20-71lbs. of coal and 11-52 of wood, making for 1,000 miles—

		Rs.	A.	P.
Coal, Mds. 252-22, at Rs. 72-4-0 ...	...	182	7	0
Wood, „ 140-19, „ 21-0-0 ...	...	29	7	0
Total	...	211	14	0

or only 25 per cent. more in cost than if wood alone were used.

5. The Locomotive Superintendent is of opinion that further experiments will show that an increase in the proportion of wood will be followed by a still greater reduction in the consumption per mile, and ultimately bring the cost of the mixed fuel to a par with the wood fuel.

6. In making the above calculations, the cost of coal when delivered at Mooltan has been put down at Rs. 72-4, being the mean rate between the maximum of Rs. 84-12 and the minimum of Rs. 59-12 shown in Consulting Engineer's No. 405-1106 of 3rd December 1864. By taking advantage of the rainy seasons for bringing down the coal from Pind Dadun Khan to Mooltan a considerable reduction in this rate might no doubt be effected.

7. The price of the wood fuel has been calculated at Rs. 21 per 100 maunds. This rate was established at the time of making up the revenue accounts to the 30th June 1862, and was based on what the wood had up to that time cost, plus 35 per cent. allowed to cover loss by drying.

This has again been looked into by the Store-keeper, who reports that experience has proved 50 per cent. may safely be taken as the actual loss from all causes; but as the fuel has of late been brought into Lahore at less expense than formerly, that Rs. 21 per 100 maunds may be considered as still representing its cost to the Company.

8. Considering the probability held out by the Locomotive Superintendent of reducing the existing excess of 25 per cent. in the cost of the mixed fuel over wood fuel, and the certainty of wood fuel becoming daily scarcer and higher in price (the report by Dr. Stewart showing that, during the past 10 years its cost in Lahore has been doubled), I recommend, as proposed by the Chief Engineer, that an average of 100 maunds daily be taken by the Railway Company to be delivered at Mooltan for employment for locomotive purposes between the reversing station and Sher Sha.

9. If the Government, through the agency of its officers now employed at the coal mines, would continue for the present to arrange for the conveyance of the coal to Pind Dadun Khan, and thence by boat to Sher Sha, this Company would be saved the expense of keeping up an establishment at those places.

It is a matter of great regret that the great cost of carriage to the Railway should preclude the extensive use of coal, which has been proved to be an efficient fuel for Railway purposes. Cheap means of transport will allow of its employment over the whole line from Umritsur to Mooltan at much less cost than wood, besides rendering the Railway almost independent of the present precarious supply of wood fuel.

From the Chief Engineer, to the Acting Agent Punjab Railway,—No. 364, *dated* 21*st December* 1864.

With reference to your No. 1259 of the 6th instant, with enclosures, on the subject of coal, and subsequently of the Consulting Engineer's No. 1122 of the 12th instant, on the same subject, I herewith forward an abstract statement by the Locomotive Superintendent, showing the approximate value for working 1,000 miles with wood or coal separately, and with wood and coal mixed, from which it appears coal alone is more than double the cost of wood fuel at the present rates; while by using them mixed, in proportion of two of coal and one of wood, the cost is only 25 per cent. above that of wood alone.

It will be seen, by the Executive Engineer's memorandum No. 449 of the 24th ultimo, that the high cost of the coal is mostly attributable to the heavy transport charges, which will prohibit their extensive use so long as wood fuel can be procured at the present rate, or until the transport charges can be reduced by the proposed Railway to Peshawur, which would probably pass at no great distance from the mines.

In a recent report by Dr. Stewart upon the supply of fuel for the Punjab Railway, he estimates the quantity obtainable at 32,78,000 maunds of dry fuel; and the annual requirements for steamers, workshops, &c., at 430,000 maunds, and for Railway purposes at 673,000 maunds, or a total of 1,103,000 maunds, which gives only three years' supply.

Under these circumstances, and the certainty of wood fuel becoming more scarce and expensive at no distant date, I recommend that an average of 100 maunds of coal per day be received at Mooltan during the year 1865 for working that section of the line between Sher Sha and the reversing station.

This will allow of the coal having a more extensive trial, and at the same time afford an opportunity of further explorations on the Salt Range.

Extract from letter from the Locomotive Superintendent, to the Chief Engineer, Punjab Railway,—No. 414, *dated* 8*th December* 1864.

I have given the coal a fair trial, and find it work the trains satisfactorily as regards its steaming qualities.

With the best specimens, from Makruth and Dhumdole, trains have been run with as little as 22lbs. per mile; but taking the coal as it comes, the good with the bad, the average is 40lbs.

I take the average cost of the coal landed at Mooltan at Rs. 72-4 per 100 maunds; wood at Rs. 21 per 100 maunds, and deduce the following:—

		Mds.	Srs.	Rs.	A.	P.
1,000 miles, at 66 lbs. of wood per mile	...	804	35	=168	3	0
1,000 " 40 " coal "	...	487	32	=351	13	0
1,000 " 20-71 lbs. " "	...	252	22	=182	1	0
1,000 " 11-52 " wood "	...	14·019	0	= 29	6	0
Total	...			211	7	0

This would show that the cost of coal *versus* wood is as 2·15 to 1; but when one-third wood is consumed with the coal, there is much greater economy.

Trains average, inclusive of engine and tender, 150 tons; and speed, 25 miles per hour.

Extract from memorandum from the Locomotive Superintendent, to the Acting Agent Punjab Railway,—No. 4, *dated* 5*th January* 1865.

The peculiar properties of this coal require a certain amount of oxygen to allow it to ignite properly; one-third wood was found to accomplish this in a great degree, and cause a more perfect combustion.

In all probability, future experiments will prove that a greater consumption of wood with the coal, say three-fifths of the former to two-fifths of the latter, will make an equivalent to the present wood consumption as regards price.

From MAJOR I. F. MACANDREW, *Officiating Secretary to the Chief Commissioner of Oudh, to the Secretary to the Government of India* HOME DEPARTMENT, *Simla,—No.* 2410, *dated Lucknow,* 26*th June* 1866.

In reply to your letter No. 879, dated 15th ultimo, I am directed to state that no coal is known to exist in Oudh, nor is there the least probability that any can ever be discovered.

From C. BERNARD, ESQ., *Secretary to the Chief Commissioner Central Provinces, to Secretary to the Government of India* HOME DEPARTMENT, *Simla,—No.* 2008-151, *dated Nagpore,* 29*th October* 1866.

I am desired by the Chief Commissioner to acknowledge receipt of your circular No. 880 of the 15th May, calling for a report on the coal resources and production of these provinces, as required by the Secretary of State for India, and to submit as follows for the information of His Excellency the Governor General of India in Council.

2. Coal has been found at several places in these provinces in the districts quoted in the margin. The accompanying sketch map, with the localities of the several coal fields marked conspicuously in black, will show their position relatively to the Railway system.

1. Nursingpore.
2. Chindwara.
3. Baitool.
4. Chanda.
5. Belaspore.
6. Hoshungabad.
7. Jubbulpore.

3. They will be treated of in the order of districts above noted, which is also the order of their relative importance, at least so far as their coal resources have been ascertained.

I. Nursingpore.—The coal field in this district is named *Mopani*, from its vicinity to a village of that name. It has been worked by the "Nerbudda Coal and Iron Company" since 1861 under the Mining license executed on the 9th September 1864, received from the Secretary to the Government of India in the Department Public Works with his No. 1191C. of the 8th December last. A copy of this license is attached (marked A.), as it particularly describes the locality and area of the license, with the conditions entered into by the Company. Annexure B. will give the result of a trial of the coal from this mine, made on the Great Indian Peninsula Railway in 1862, which proved the Mopani coal to be somewhat inferior to English coal.

4. This field is described in the Memoirs of the Geological Survey of India, Vol. II., Part 2, page 169. In the section exposed in the gorge through which the Sita Riba River escapes from the hills (*vide* Annexure C.), the three seams of coal aggregate 19 feet thick,—the first seam being 10 feet, the second 5 feet, and the third 4 feet. These, and another seam at the neighbouring village of Berar, 4 feet thick, are described as capable of turning out large supplies of good coal. The locality is easily accessible, and little above the general level of the Nerbudda Valley. The Railway from Bombay to Jubbulpore and Mirzapore passes within ten miles north of the mines; and as they will be connected with the rail by a tramway, the advantages of the position will enable the Company to compete favorably for the supply of the line from Bhosawul to Jubbulpore, perhaps even to Mirzapore, and also to places beyond Bhosawul on the other side.

5. Mr. Temple visited these mines in 1862, and in his Administration Report for 1862-63, paragraph 347, wrote :—"I entered two long passages excavated on the side of the hill. The coal appeared to be good, and its supply to be very considerable." He understands that since that time further operations have been carried on.

6. The actual production at these mines has not yet been ascertained; and though mining has been going on for some time, and stock accumulated, the annual rate of production will not probably be known till the article comes fully into demand by the completion of the Railway to Jubbulpore, towards which point the rails are now progressing from the north and west.

7. I am to add that a large specimen of this coal was sent to the Nagpore Exhibition in December 1865, and was highly thought of by the professional men who saw it.

II. CHINDWARA.—In this district, Burkoee is one of the oldest known fields, and has been experimentally worked since 1860 by Mr. Stanbrough, under a lease which terminates in April 1868. It was first discovered in 1852, and was mentioned by the late Reverend Mr. Hislop in his Memoir "On the age of the coal strata in Western Bengal and Central India," published in the Journal of the Asiatic Society of Bengal, Vol. XXIV., page 347. The paper was also published in 1855 in the Quarterly Journal of the Geological Society of London.

8. A quantity of the coal from this mine was sent for analysis to Bombay in 1860, and the annexure D. will afford information as to its value compared with the Nerbudda Valley and English and Australian coal.

9. The mine was visited by Colonel Harley Maxwell, Chief Engineer, in 1861, when he reported that "the extent of the present known coal is decidedly limited; it measures about two feet in thickness, one foot of which may be considered good coal; the remainder has much of lignite mixed with it; but still the whole burns freely together, and will be invaluable for brick burning and other building operations. For three miles this seam is traced along the bed of a stream; and allowing this spot to extend one and a half miles on each side of the stream, there will be about nine square miles, or thirteen and half million tons of coal."

10. Mr. Temple himself visited this coal field in 1863, and in his Administration Report for that year wrote as follows:—"I have visited the mine in company with the Reverend Mr. Hislop, who was one of the first to bring the place to notice. It has been worked by Mr. Stanbrough with some success. The section now laid open here affords promise of a much larger supply than was previously anticipated. At the time of my last report the thickness of the seam was supposed to be one foot, but this has now been discovered to be four and a half feet, half of which consists of good coking coal; and although, as previously stated, the place is somewhat removed from the main road of traffic, yet, if the mine should prove really valuable, the construction of a good road would bring the coal by 90 miles of easy transit to Nagpore."

11. In December 1863, a proposal was received from Mr. Acton Ayrton, a Director of the Great Indian Peninsula Railway, to work the Burkoee and Shahpore coal mines (the latter in the Baitool district); and if the negotiations now progressing come to a successful termination, the former, or Burkoee field, will be connected by tramway with the Railway terminus at Nagpore, a distance of some 80 odd miles; and the latter, or Shahpore field, with Itarsee on the Great Indian Peninsula Railway, a distance of some 30 miles between Bhosawul junction and Jubbulpore.

12. Up to date of last report, the out-turn from the Burkoee mine was some 900 tons; but of course this does not represent what might have been produced were a full colliery establishment employed, and were there a brisk demand for the article locally.

13. More recently, further discoveries of coal have been made in this neighbourhood east and north-east of Burkoee, over a length of 16 miles in the Pench Valley.

14. The Deputy Commissioner of Chindwara has reported further discoveries; and the Commissioner of the Nerbudda division has been requested to place a moderate, but suitable, sum at this Officer's disposal for prosecuting his researches, which, when complete, will be reported hereafter.

15. The Chief Commissioner would here observe that Major John Ashburner, the Deputy Commissioner, deserves marked credit in respect to these last-named discoveries, which have been chiefly made either by him or through his instrumentality.

III. Baitool.—The several out-crops of coal in this district are mentioned in the Memoirs of the Geological Survey of India, Vol. II., Part 2, and will be found epitomized in Appendix A. of that volume, pages 268 and 270 (see Annexure F.) Since Mr. Medlicott reported on them, they have been again recently visited by Mr. Blanford of the Geological Survey, and his report is annexed, marked G. No new discovery has been made in this district, and the six known out-crops will be found minutely described by Mr. Blanford. The Rawundeo section is the most important, exposing one or two seams of four feet thickness each, all the others being less than that, and not affording so promising a field for mining operations.

16. These several fields are from 30 to 38 miles from Itarsee, the nearest station on the Railway, running through the Hoshungabad district to the north; and should they be worked by the Company which Mr. Ayrton has proposed forming, they could be easily linked on to the Railway system by a tramway.

IV. Chanda.—The discovery of a coal seam in this district is of a more modern date, and is due entirely to Captain Lucie Smith, the Deputy Commissioner of the district. Seams have been found at three places on the Wurdah River between the latter part of 1865 and beginning of 1866. The fields have not yet been examined by the Geological Survey, so that no minute description can be given of the number and thickness of the seams exposed in the several sections.

V. Belaspore.—In this district coal is found at four places in the Koorba and Ooprorah zemindarees on the north-eastern frontiers. They were first discovered in 1840, and were visited in 1863 by Captains Burton and Forsyth, when exploring the forests in that direction. Their account will be found at pages 165 and 166 in the Volume of Selections from the Records of the Government of India in the Public Works Department of 1864. The Husdoo and its tributaries, on which the out-crops occur, is navigable for about 30 miles above its junction with the Mahanuddy, which from this point to the sea, 350 miles, is navigable for some months of the year. A full description of this river system will be found in Section 2 of Mr. Temple's Mahanuddy report, forming Vol. XLIII. of the Selections from the Records of Government of India in the Public Works Department, published in 1864.

VI. Hoshungabad.—Some out-crops of coal have been discovered in the Hill Ranges forming the southern boundary of this district. The Settlement Officer, Mr. C. Elliot, in his report, Chapter I., on the Physical Features and Geography of the country (1865), thus alludes to

them:—"Coal is to be seen everywhere in the streams which cut the sandstone, but no seams have yet been found worth working." The locality has not yet been examined by the Geological Survey, but next year it is probable that their investigations will extend in this direction.

VII. JUBBULPORE.—Some thin seams of coal have been found in the Bijeeragoghur sub-division of this district, the principal of which is one 18 inches thick, found in the lesser Mahanuddy, a tributary of the Soane, near the village of Binpar. It is described as probably not workable; but its examination by a professional person at the earliest opportunity would be desirable.

17. In 1839 a seam of shale on the Sameta Ghaut near Jubbulpore was discovered by Dr. Spilsbury; and in the report of the Coal Committee for 1845, the bed is spoken of as "a very large bed of coal, many yards in thickness, and of first-rate quality." But in 1844-46, Mr. Rammel, an accomplished Engineer, sunk pits and shafts on the Sameta Ghaut shale "in the hope," as Mr. Medlicott writes in his report on the Geological structure of the Nerbudda Valley, "that what was rubbish at the out-crop might prove cleaner inside; but he was soon obliged to abandon it as useless."

18. In conclusion I am to express Mr. Temple's hope that the information afforded in this despatch may be found of some use. Though manifestly imperfect, it is the best which the present state of our knowledge enables him to offer.

ANNEXURE A.

Mining license to the Nerbudda Coal and Iron Company.

This Indenture made the 9th day of September 1864 between the Secretary of State for India in Council of the one part and the Nerbudda Coal and Iron Company Limited of the other part.

1. Whereas the said Company have applied to the said Secretary of State in Council to grant unto them the license and privileges hereinafter contained and the said Secretary of State in Council has in consideration of the several annual payments royalties and covenants hereinafter reserved and contained and upon the condition that the said Company would before the execution of these presents satisfy the Governor General of India in Council that the capital of two lakhs of Rupees has been duly subscribed and is immediately available for the purposes of the said Company and the works hereinafter mentioned and upon the other conditions hereinafter contained agreed to grant to the said Company such license and privileges.

2. And whereas the said Company have satisfied the Governor General of India in Council that the said capital or sum of two lakhs of Rupees has been before the execution of these presents duly subscribed by the shareholders of the said Company.

3. Now this Indenture witnesseth that for the purpose of carrying the said agreement into effect and in consideration of the annual payments royalties and covenants herein reserved and contained and by and on the part of the said Company their successors or assigns to be observed and performed the said Secretary of State in Council doth

hereby grant unto the said Company their successors and assigns (who are hereinafter referred to as the grantees)

4. Full and free license to mine and search for and to work smelt and manufacture all the coal and iron and other ores together with such limestone building stone and other minerals as shall be required for the purpose of working the coal and iron and other ores lying and being in under or upon and which may be gotten (without disturbing the beneficial occupation of any persons whatsoever who may from time to time be in lawful occupation of any parts of the surface of the said lands and without interfering with or in any manner affecting any rights in or to the said surface) in out of or upon all those two several tracts of land hereinafter particularly described that is to say all that tract of land situate in the Central Provinces of India and butted and bounded on the north by the Nerbudda River on the east by a line drawn due north and south from the point of exit of the Hurd River from the Gondwara Hills to the Nerbudda River on the south by a line drawn due east and west so as to intersect a due north and south line drawn through the town of Mopani at a point two miles south of the escarpment of the said gondwara Hills and on the west by a line drawn due north and south from the point of exit from the said Hills of the Sita Rewa River to the Nerbudda River and also all that other tract of land in the district aforesaid butted and bounded on the north by the foot of the Vindya Hills north of Tandakhera on the east by a line drawn due north and south through a point two miles due east of the town of Tandakhera and extending from the foot of the said hills to the Nerbudda River on the south by the Nerbudda River and on the west by a line drawn due north and south through a point four miles due west of the said town of Tandakhera and extending from the foot of the said hills to the Nerbudda River (and which said several tracts of land are intended to be hereafter more particularly defined by proper boundary pillars surveyed and mapped under directions of the Government of India and the said boundary pillars and maps or map when completed shall be taken by both parties hereto as correctly defining and delineating the said tracts in the same way as if such boundary pillars had already been erected and such maps or map had been drawn upon or annexed to these presents.

5. Together with full and free license for the said grantees (but without prejudice to such beneficial occupation or to any rights in the surface as aforesaid) to sink and make mines shafts drifts air-courses water-gates and water-courses and other works as well for the obtaining coal iron or other ores and the limestone building stone and other minerals for working such coal and ores from or out of the said lands and more conveniently working any mines which may be opened on the said lands as for the avoiding and carrying away of water or foul air from the said mines or for conveying air into the same. And also without prejudice as aforesaid to take and use sufficient and convenient heap-room and ground-room for laying all such coal iron and other ores and such limestone building stone and other minerals as shall as aforesaid from time to time be got upon or out of the said lands.

6. Together with full and sufficient way leave and passage to and for the said grantees and their agents servants and workmen at all times

during the term hereby granted to carry away in carts wagons or any other manner the coal iron and other ores and such limestone building stone and other minerals as aforesaid to be got upon or out of the said lands through or over the said lands or any part thereof to or towards such coal-staiths smelting works or other places as the said grantees or their agents in that behalf shall think expedient (but without disturbing the beneficial occupation of any persons as aforesaid who may be in lawful occupation of any parts of the surface of the said land and without interfering with or in any manner affecting any rights in or to the said surface) and with full license upon the said lands or any part thereof to make wagon-ways bye ways side-ways roads foot-paths branches bridges and cuts for wagons and other carriages laden or not laden labourers and others to pass and re-pass over and along the same and to repair the same or any of them as often as occasion shall require.

7. Together also with full and free license upon the same lands to erect such kilns furnaces and works for the smelting working and manufacturing of iron or other ores so found in under or upon the said land and such houses buildings engine-houses store-houses sheds and other erections as may be found necessary or proper for smelting working or manufacturing drawing or raising laying or placing the said iron and other ores and all materials to be used in and about the said works and for the residence of workmen and others to be employed in or about such works as aforesaid and for all other purposes necessary or proper for the said works or for the getting of coal or the getting or smelting working or manufacturing of iron or other ores or for the getting such limestone building stone and other minerals as shall be required as aforesaid but so always as that as little damage be done as reasonably may be to the said lands by the erection of the said works (and without prejudice to such beneficial occupation or to any rights in the surface as aforesaid).

8. And also license over and throughout such portions of the said lands as shall hereafter from time to time be pointed out by the Executive Government of the said Central Provinces and subject to such special conditions as shall by such Government be from time to time imposed in that behalf to cut trees for the purpose of making charcoal or obtaining fuel or timber for the use of the said works and not for sale or otherwise.

9. And also with full and free license in or upon the said tracts of land to do anything which may be necessary or convenient for or about the searching for or getting of coal iron or other ores or minerals building stone or limestone as aforesaid in upon or out of the said lands or the smelting of such ores or the using of such building stone limestone or other minerals or the carrying of coal iron or other minerals limestone or lime fuel timber or other materials to or from such smelting-works or other works as aforesaid (without prejudice to such beneficial occupations or rights in the surface as aforesaid).

10. And also full license to use any streams of water running through the said lands or any part thereof for the purpose of driving any machinery which may be employed in or about the said works or

for any other purpose connected with the said works but so however that no irrigation works existing at the time of the execution of these presents or which may during the continuance of these presents be in existence whether the same be lawfully and of right made and established or not be thereby interfered with either directly or indirectly and so also that such use by the grantees of such streams shall not in any way cut off or diminish the water supply to any village or inhabited place within such tracts of land nor contaminate or injure the quality of such water supply.

11. Excepting and reserving always unto the Secretary of State in Council his successors or assigns out of this present grant full right to have and use and to grant to any other persons whomsoever any way-leave or passage to or from or for the use of any other collieries iron-works or other works or places whatsoever in through over and along the said lands or any part thereof with liberty to the said Secratary of State his successors and assigns and his and their grantees and lessees to make wagon-ways side-ways tramroads or other roads or ways and there-with to cross and intersect any tramroads wagon-ways or other roads or ways made by the said grantees and to pass and repass over and along such ways and crossings with horses or other beasts of burthen waggons and other carriages laden and unladen but so as the same do not prejudice or damage the wagon-ways tramroads or other ways or roads made by the said grantees otherwise than by crossing or intersecting the same and so as in such crossing thereof no unnecessary interruption be given to the said grantees their agents servants or workmen and so as the places of such crossings be made and repaired and kept in repair by and at the expense of the persons making or using the same respectively.

12. To hold and enjoy the said license and authorities hereinbefore granted or expressed and intended so to be unto the said grantees from the 1st day of January 1861 for the term of 50 years thence next ensuing and fully to be complete and ended yielding and paying unto the said Secretary of State in Council his successors or assigns the sum of Rs. 100 per annum for the first five years of the said term and the sum of Rs. 1,000 per annum for the residue of the said term and also yielding and paying unto the said Secretary of State in Council his successors and assigns from and after the expiration of the fifth year of the said term the sum of one Rupee for every 30 Indian maunds of iron which shall be smelted or manufactured at the said iron-works the sum of eight anna for every 30 Indian maunds of iron-ore which may be got out of or upon the said lands and sold by the said grantees without being smelted or manufactured and the sum of four annas for every 30 Indian maunds of coal which shall be got out of the said lands and sold by the said grantees and also yielding and paying unto the said Secretary of State in Council his successors or assigns such sums of money for or in respect of all such other ores and all manufac-tures produced from such other ores as shall or may be raised and got out of the said lands or manufactured at the said works and sold by the said grantees as the Governor General of India in Council or the said Executive Government shall from time to time consider to bear the same proportion to the value for the time being of such other ores or manufac-

tured produce from ores as the royalty hereby fixed for smelted iron shall bear to the value for the time being of that metal the said annual sums of Rs. 100 and Rs. 1,000 and the said other sums of money hereby reserved to be paid yearly on the 1st day of January in each year and in such manner that the whole amount to which the sums of money hereby reserved or made payable as aforesaid shall have amounted to for and during the year preceding the 31st day of October next before such day of payment shall be then paid the first payment to be made on the 1st of January 1861. Provided however that the said sum of Rs. 1,000 per annum hereinbefore reserved shall merge in and be in part payment of the said royalties hereinbefore reserved whenever the yearly amount of such royalties shall exceed Rs. 1,000 and that whenever the yearly amount of the royalties shall be less than the sum of Rs. 1,000 the amount of such royalties shall merge in and be in part payment of the said yearly sum of Rs. 1,000.

13. And the said grantees do hereby covenant with the said Secretary of State in Council his successors and assigns in manner following that is to say that they the said grantees shall during the said term hereby granted cause to be paid unto the said Secretary of State in Council his successors or assigns the several sums of money and royalties hereinbefore reserved and made payable at the times when the same shall respectively become due and payable and in the manner hereinbefore appointed for payment thereof without any deduction or abatement whatsoever.

14. And further that if the several sums of money and royalties hereby reserved or made payable or any of them or any part thereof shall be unpaid by the space of 21 days next after the day whereon the same ought to be paid as aforesaid (and whether the same shall have been demanded or not) it shall be lawful for the said Secretary of State in Council his successors or assigns or for the Governor General in Council or the said Executive Government on his or their behalf to stop the taking away of coal iron-ore iron limestone or other ores minerals or metals from the said lands and to seize and distrain any machinery engines plant utensils horses cattle carts carriages or other live or dead stock and any coal iron-ores metals minerals or stone charcoal wood fuel and building and other materials which shall be remaining upon or within the boundaries of the said tracts of land respectively or any of them or any part thereof and the same to impound sell and dispose of for and towards the satisfaction of all such sums of money or royalties as aforesaid and also of all costs and expenses incident to such distress in the like manner as any rent whatsoever can or may be recovered by distress at law.

15. And also that they the said grantees shall cause to be kept fair and legible books of account in English with true regular and exact entries therein of the weight and quality of all iron and other metals manufactured at the works to be erected on the said lands and also of such ores as may be got on or out of the said lands and smelted at such works and also of the weight and quality of all such iron-ore and other ores as may be got on or out of the said lands and sold without being smelted or manufactured and also of the weight of all such coal as may be got on or out of the said lands and sold by the said grantees.

16. And shall at all times when thereunto required produce such books of account or any of them to such persons as the said Secretary of State in Council his successors or assigns or the Governor General of India in Council or the said Executive Government shall in that behalf from time to time appoint and permit such persons to take or if required furnish them with any extracts therefrom or abstracts or copies thereof and give any explanation which may be required in relation thereto.

17. And shall in all other respects give every facilty and means to such persons as the said Secretary of State in Council his successors or assigns or the Governor General of India in Council or the said Executive Government shall in that behalf from time to time appoint to ascertain at all times the quantity and quality of iron and other metals manufactured at the said works and of ores got on or out of the said lands and sold without being smelted or manufactured and of coal got on or out of the said land and sold as aforesaid to the end and intent that the amount of royalties from time to time payable may be known.

18. And shall concur in any arrangements which may be reasonably devised and proposed for effecting the object last hereinbefore mentioned and shall yearly or oftener if thereunto required cause to be verified the contents of entries in such books of account as aforesaid by a declaration in writing under the hand of the agent in India of the said grantees.

19. And the said grantees do hereby further covenant with the said Secretary of State in Council his successors and assigns that they the said grantees shall within five years from the opening of the Railway from the Jumna at Allahabad to Jubbulpore or from the opening of the Railway from Bombay to Jubbulpore (whichever of those Railways shall be first opened) produce and manufacture at the said iron-works at least 5,000 tons of marketable iron.

20. And shall from and after the expiration of such five years and until the expiration of the said term of 50 years manufacture at the said works at least 1,500 tons of merchantable iron per annum.

21. And also shall observe and obey all such orders and conditions as shall from time to time be made or imposed by the said Executive Government as respects the cutting of trees for fuel timber or charcoal for the said works and also shall in case of every breach of any of such orders or conditions pay to the Secretary of State in Council his successors or assigns as or by way of liquidated damages and not by way of penalty such sums not exceeding Rs. 500 for each and every such breach as the said Executive Government shall in and by the said orders or conditions in that behalf appoint.

22. Provided always that before any orders or conditions shall be made or imposed as respects the cutting of trees as aforesaid or shall afterwards be amended or altered notice of the intention to pass such orders or conditions or to make such alteration as aforesaid shall be given to the said grantees or their agent in India who shall be at liberty within two weeks after they or he shall have received such notice to state their or his objections (if any) to the said Executive Government by whom such objections shall be considered and disposed of.

23. And also that they the said grantees shall not nor shall any transferee from them at any time assign underlet or otherwise part with to any person the license and privileges hereinbefore granted or expressed and intended so to be or any of them or any part thereof for the whole or any part of the said term hereby granted without the consent and approbation in writing to every such transfer of the Governor General of India in Council or of some person appointed in that behalf by the said Governor General in Council or by the said Secretary of State in Council his successors or assigns for that purpose first had and obtained.

24. And further that the said grantees shall at all times at their own expense keep in repair all such ways paths and roads (not being public roads made by or at the expense of the Government) as shall be used by them in working and mining the said tracts of land or in getting and carrying away the produce thereof or otherwise by virtue of these presents.

25. And shall at all times during the said term fairly work and exercise the license hereby granted in the best and most approved manner applicable in this country to the working of such a license and shall not do anything to cut off limit contaminate or injure the water supply to any villages or inhabited places within the said land.

26. And shall at all times keep all mines erections and works which shall be opened or worked or such of them as for the time being can be worked with advantage and the matters and things thereto belonging in proper condition and repair and shall erect and during the said term keep in efficient working order all such shafts steam engines air pumps and other works as shall be necessary for the proper and sufficient ventilation of every part of the mines to be opened by the said grantees on the said lands.

27. And the same mines erections and works so kept in proper condition and repair and well and sufficiently ventilated at the end or sooner determination of the said term hereby granted shall quietly give up and surrender unto the said Secretary of State in Council his successors or assigns or to such person or persons as he or the Governor General in Council shall appoint to receive the same but so nevertheless that unless the said term shall be determined by re-entry under the clause for forfeiture and re-entry hereinafter contained it shall be lawful for the said grantees to remove for their use all the coal iron and other ores stone minerals charcoal fuel and timber which shall have been got or prepared by them previously to the expiration of the said term and also all erections buildings engines tools and plant of the grantees at the time being in or upon the said lands and used for the purposes aforesaid the said grantees using all reasonable despatch in removing the same and leaving the lands on which the same shall stand in as good a condition as they would have been in if such erections buildings engines or plant had not been built or fixed thereon and rendering and paying forthwith the full royalties and sums of money payable in respect of the said coal iron and other ores according to the true intent and meaning of these presents and also first giving to the Secretary of State in Council his successors or assigns or to the Governor General

in Council the option of purchasing such erections buildings engines working tools machinery or plant and also the said coal ores mineral stone charcoal fuel and timber got or prepared as aforesaid or any part thereof at a fair valuation as hereinafter provided.

28. And also that it shall be lawful for any persons appointed in that behalf by the said Secretary of State in Council his successors or assigns or by the Governor General in Council or the said Executive Government at any time during the continuance of the term hereby granted to enter or descend into and upon any of the mines works or premises for the time being opened erected or occupied under this present license and to inspect the manner of working the same and the state and condition thereof. And that for the purposes of such inspection the said grantees shall during the said term whenever required produce to the persons authorized to inspect as aforesaid detailed and accurate plans of the then mines underground working shafts and adits constructed or opened in or under any part of the said lands and shall deposit copies of such plans whenever required with the Secretary to the Government of India in the Public Works Department or the said Executive Government.

29. And if any fault or defect tending to prejudice the interests of the Government of India or of the public in the premises shall in the judgment of the said Inspectors appear in the working or conduct of any part of the said mines or premises or in the state or condition thereof or the precautions used for working the same with due regard to the safety of the public and of the workmen employed thereon then the said grantees shall on receiving notice to that effect from such Inspectors as aforesaid as soon as conveniently may be repair and amend the same and keep the said mines works and premises in proper repair and working condition and shall at all times render every reasonable facility and assistance for making such inspection as aforesaid unto all the persons hereinbefore authorized to make such inspection as aforesaid.

30. And also that if during the continuance of the said term any accident shall take place in or about the said mines works and lands or any part thereof involving loss of life or limb or serious injury to any person the said grantees shall forthwith cause notice thereof to be given at the police station nearest to the place where such accident took place.

31. And also that the said grantees shall not commit any unnecessary damage or waste in or upon the aforesaid lands and premises or any part thereof or the trees growing thereon in the carrying on the said works or in the exercise of the powers hereinbefore contained.

32. And also that the said grantees shall fence round and fill up level and cover in a proper substantial manner to the satisfaction of the said Secretary of State in Council his successors and assigns or of the Governor General in Council or of the said Executive Government all such mines pits shafts and other works as may have been wrought out or can no longer be worked to advantage.

33. And shall make fair compensation to any tenants or occupiers of any part of the surface of the lands and to any other persons whomsoever for any damage or loss which may be sustained by them

in consequence of the said works or in the execution of the powers and authorities in these presents contained or anything which may be done in pursuance of these presents so far as any such tenants occupiers or other persons shall be entitled to such compensation.

34. And shall keep harmless and indemnify the said Secretary of State in Council his successors and assigns and all persons entitled to or interested in the lands hereinbefore mentioned or any part thereof from all actions suits claims and demands on account or in respect of any such damage or loss as aforesaid.

35. Provided always and it is hereby agreed and declared by and between the parties hereto that if the grantees or their agent shall dissent from the opinion of the Inspectors under the 32nd Clause hereof as to the condition working or ventilation of any part of the said mines or works the question in dispute shall be referred to the decision of a professional Mining Engineer to be agreed on between the said grantees and the Government of India or the said Executive Government in that behalf so that such referee shall be agreed on within six months next after the said Inspectors have made the inspection in respect of which the difference of opinion arose. The decision of such Engineer referee shall be final and binding on both parties hereto and should his decision substantially coincide with the opinion of the Inspectors the said grantees shall pay all costs of or consequent on the reference.

36. Provided also and it is hereby agreed and declared between and by the said parties to these presents that if the royalties and sums of money hereinbefore reserved or any of them or any part thereof shall be unpaid for the space of 60 days over or after the times when the same respectively shall have become payable according to the true intent and meaning of these presents or if the said grantees shall not faithfully keep and perform all and every the covenants conditions and agreements herein contained and on their part to be kept and performed then and in every such case it shall be lawful for the said Secretary of State in Council his successors or assigns by his or their Officers into and upon the said lands or any part thereof in the name of the whole or into or upon any such buildings or works as hereinbefore mentioned to enter and thenceforth to re-possess the same together with all engines machinery and plant affixed to the soil (but not the engines machinery plant or working tools not affixed to the soil) and all coal iron and other metal iron and other ores stone and minerals charcoal fuel and timber then being on or under the said lands or premises to and for the proper use of the said Secretary of State in trust for Her Majesty and the said term of 50 years and all the license powers and authorities hereby granted shall thereupon absolutely cease and determine.

37. Provided also and it is hereby further agreed and declared between and by the parties to these presents that if the said grantees shall fail to produce and manufacture at the said iron-works at least 5,000 tons of marketable iron within five years from the opening of the Railway from the Jumna at Allahabad to Jubbulpore or from the opening of the Railway from Bombay to Jubbulpore (whichever of those Railways shall be first opened) or to manufacture at the said works at least 1,500 tons of iron per annum from and after the expiration of such

period of five years but shall prove to the satisfaction of the Governor General of India in Council that such failure was occasioned by or was attributable to causes over which the grantees could have had no control and not to any mismanagement or neglect on the part of the said grantees their agents or servants then the said Secretary of State in Council his successors or assigns shall not exercise the power of re-entry reserved to him and them by the proviso lastly hereinbefore contained.

38. And the said Secretary of State in Council doth hereby for himself his successors or assigns covenant with the said grantees that it shall be lawful for the said grantees paying the several royalties and sums of money hereinbefore reserved and made payable and observing and performing the covenants conditions and agreements in these presents contained and on their part to be observed and performed at all times during the continuance of the term hereby granted peaceably and quietly to get and take the said coal iron and other ores limestone building stone and minerals as aforesaid and to have and exercise the said license and privileges hereinbefore granted or expressed and intended so to be without any interruption or disturbance of or by the said Secretary of State in Council his successors or assigns or of any person or persons whomsoever lawfully claiming or to claim by from under or in trust for him them or any of them.

39. And also that in the like case the said Secretary of State in Council his successors or assigns shall not nor will during the said term of 50 years license or empower any other persons or bodies corporate to search for raise or get any coal iron or other ores on in or out of the lands comprised within the boundaries hereinbefore specified or any part thereof nor erect nor authorize any other person or persons or body or bodies corporate to erect or construct any works for the smelting or manufacturing of iron or other ores within the said boundaries.

40. And also that the Secretary of State in Council shall not cause any alteration to be made in the existing irrigation works on the said lands nor any new irrigation works to be commenced thereon until after the expiration of six months' notice to the said grantees or their agent of the intention of the Government to make such alteration or to construct such new works.

41. And also that the said Secretary of State in Council his successors or assigns shall not during the said term convey or demise the surface or soil of any portion of the said lands without at least two months' previous notice to the said grantees and in case the said grantees their successors or assigns shall within the said period of two months after such notice or within such further period as the Governor General of India in Council or the said Executive Government shall allow for that purpose satisfy the said Governor General of India in Council or the said Executive Government that any such intended conveyance or demise will be prejudicial to the fair and proper use and working of the mines or works or to the reasonable enjoyment by the grantees of any of the privileges hereby granted to them then that the said Secretary of State in Council his successors or assigns shall not make any such conveyance or demise as long as the said Governor

General in Council or the said Executive Government shall be satisfied that the same will be prejudicial as aforesaid.

42. Provided always and it is hereby expressly declared and agreed that the license and privileges hereby granted shall not nor shall anything hereinbefore contained give any right or authority to the said grantees to prevent interfere with or limit any right or easement whatsoever (whether strictly legal or not) which at the time of the execution of these presents and for 10 years preceding shall have been exercised or enjoyed by any individual or by the public within any part of the said lands. But that it shall be lawful for the said grantees to contract with any persons exercising such right or easement as aforesaid for the cession and surrender thereof and all moneys which shall with the approval of the Government of India or of the said Executive Government to be conveyed to the said grantees in writing and not otherwise be paid by the grantees in consideration of such cession or surrender shall be repaid to them by the said Secretary of State on the expiration of the term hereby granted unless such term shall be determined by forfeiture and re-entry in which case the Secretary of State shall on re-entry hold the said lands freed and discharged from such right or easement.

43. And it is hereby further agreed and declared between the said parties hereto that if the said grantees shall be desirous of determining their liability under these presents at the end of five years from the said 1st day of January 1861 and of such their desire shall give to the said Secretary of State in Council his successors or assigns or to the Governor General of India in Council at Calcutta not less than six calendar months' previous notice in writing and if the said grantees shall at or before the expiration of such five years pay and discharge the several royalties and sums of money hereinbefore reserved or made payable and which shall then have become payable and perform and fulfil the several covenants conditions and agreements herein contained and on their part to be performed and fulfilled up to that time then at the end of the said term of five years from the said 1st day of January 1861 as well the liability and also the interest license and privileges of the said grantees under these presents shall cease and determine.

44. And it is hereby further agreed and declared between the parties hereto that the said Secretary of State in Council his successors and assigns and the Government of India shall respectively from time to time give the said grantees such aid in respect of taking the surface of the soil and of land for tramways ways or approaches to and from the said intended mines and works as the Governor General of India in Council or the said Executive Government from time to time may see fit and as may be consistent with the rights of others and otherwise lawful.

45. Provided always and it is hereby agreed and declared between and by the said parties to these presents that it shall be at the option of the said Secretary of State in Council his successors or assigns at the expiration of the said term of 50 years either to renew the license and privileges hereby granted for a further term of 50 years (but at or under such royalties or sums of money as are hereinbefore reserved or made payable for during or in respect of the last 45 years of the said term of

50 years hereby granted) or to take over the buildings machinery and plant which may be then erected and in use on or about the said lands mines or works at a valuation to be made by two persons one to be named and chosen by the Governor General in Council on behalf of the said Secretary of State in Council his successors or assigns and the other by and on behalf of the said grantees and in case such two persons cannot agree in the said valuation then such valuation is to be determined by arbitration in the manner hereinafter mentioned.

46. Provided also and it is hereby further agreed and declared between and by the said parties to these presents that if any doubt difference or dispute other than one of the kind provided for by the 38th clause hereof shall at any time hereafter arise between the said parties hereto their respective successors or assigns touching the valuation referred to in the lastly preceding clause or the quantity or quality of any of the things for which any royalties are reserved or ought to be paid under these presents or touching the manner in which the said license or privileges so granted or agreed to be granted as aforesaid or any of them ought to be exercised or used or touching the construction of these presents or any other matter or thing whatsoever arising out of these presents or having relation to the premises and in respect of which the decision of the Governor General of India in Council or the said Executive Government is not hereby made final then and in such case and as often as the same shall happen such doubt difference or dispute shall be submitted and referred to the arbitration of three indifferent persons one to be appointed by the Governor General of India in Council or any person lawfully exercising the powers of the Governor General of India in Council or the said Executive Government and another to be appointed by the said grantees within one calendar month after either of them the said parties in difference shall have made to the other a requisition to that effect and the third to be named by the said two persons so appointed as aforesaid within one calendar month after they shall have been themselves chosen and further that if either of the parties so doubting differing or disputing as aforesaid shall by notice under the hand of some person authorized in writing by the said grantees or their agent in India (in case the same shall be given by or on behalf of the said grantees) and under the hand of one of the Secretaries of the said Executive Government or of one of the Secretaries to the Government of India (in case the same shall be given by or on behalf of the said Secretary of State in Council his successors or assigns) require the other of the said parties to submit and refer to arbitration and to name some person as arbitrator and if the party to whom such requisition shall be made shall for the space of one calendar month after such requisition neglect or refuse to comply therewith or shall name a person who shall refuse or for one calendar month neglect to act as arbitrator then and so often as the same shall happen it shall be lawful for the person chosen to be arbitrator on behalf of the party making such requisition by any writing under his hand to appoint an arbitrator to act as arbitrator on behalf of the party who or whose arbitrator shall refuse or neglect as aforesaid and that such two persons shall name a third arbitrator as aforesaid and further that it shall be lawful for the said arbitrators or any two of them to arbitrate determine and award of and concerning all and

every the matters and things touching which such doubt difference or dispute as aforesaid shall have arisen and (if they or any two of them shall see fit so to do) at the expense of the parties in difference or one of them to call in the aid and take the opinion either of any person or persons having experience in the management of coal mines or iron works or of counsel or of any other person or persons and to adopt such other measures as shall appear to the said arbitrators or any two of them advisable or expedient and further that the parties so doubting differing or disputing as aforesaid and all persons claiming by from through or under them respectively shall in all things obey abide by observe and perform the award order and determination of the aforesaid arbitrators or of any two of them so as the award of the said arbitrators or of such two of them as shall concur be made in writing under their hands and be ready to be delivered to the said parties respectively or such of them as shall desire the same within three calendar months next after the third of such three arbitrators for the time being shall have been named or within such further time as the said arbitrators or any two of them shall from time to time in that behalf appoint and that the said parties so doubting differing or disputing as aforesaid will so far as in them respectively may lie furnish all such documents proofs and evidence and do or cause to be done all such acts and things for better enabling them to make the said award as the said arbitrators or any two of them shall require and that the costs charges and expenses of and attending or in any wise relating to any arbitration including the compensation to be made to the arbitrators for their trouble and the fees and compensation to be paid and made to any counsel or other person or persons who may be called on as aforesaid shall be in the discretion of the said arbitrators or any two of them who shall direct by whom and to whom and in what manner the same shall be paid and that any submission or reference to arbitration under or by virtue of these presents may be made a rule of the High Court of Judicature at Fort William in Bengal according to the statute in that case made and provided if the said Court shall so please and either party shall be at liberty to apply to the said Court for that purpose and to instruct counsel to consent thereto for the other party and that in case either of the parties hereto after being duly required so to do by the other party hereto shall refuse or neglect to submit any such matter in difference as aforesaid to arbitrators to be appointed in manner aforesaid or to abide by or perform the award of the said arbitrators or any two of them made in pursuance of these presents or shall make any attempt to revoke the authority of the arbitrators to be appointed in pursuance of these presents or of any or either of such arbitrators the party so refusing or neglecting shall besides and without prejudice to any other remedy to which the other party may be entitled for every such refusal or neglect pay to the other party Rs. 50,000 not by way of penalty but by way of liquidated damages.

47. And it is also agreed that any notice order or condition to be given made or imposed for any of the purposes aforesaid shall be sufficient and binding if signed by one of the Secretaries to the Government of India or one of the Secretaries of the said Executive Government or by any other Officer duly authorized to act in behalf of the said Secretary of State his successors and assigns.

48. And the said grantees do further covenant to keep at all times at such place within the said Central Provinces of India or elsewhere as may be agreed upon between them and the said Executive Government an agent or agents duly authorized in their behalf with whom the Governor General in Council or the said Executive Government may communicate on all things relating to the affairs of the grantees or these presents and all acts done by such agent or agents on behalf of the grantees shall as between the said grantees and the Secretary of State his successors and assigns be binding on the grantees.

49. And it is hereby lastly declared and agreed that throughout these presents (except where the context shall otherwise require) words used in the plural shall include the same words used in the singular and that the words "Executive Government" shall mean the Officer for the time being having charge of the Local Administration of the province in which the said lands are situate.

In Witness &c.

ANNEXURE B.

From J. B. PEILE, ESQ., *Under-Secretary to the Government of Bombay, Railway Department, to the Secretary to the Government of India Public Works Department,—No.* 878, *dated* 22*nd August* 1862.

I am desired to transmit, for the purpose of being laid before His Excellency the Governor General of India in Council, the accompanying copy of a report by the Locomotive Superintendent of the Great Indian Peninsula Railway Company on the trial of some coal forwarded by the Nerbudda Coal Company for experiment.

From F. J. CORTAZZI, ESQ., *Locomotive Superintendent, to the Acting Secretary Great Indian Peninsula Railway Company,—No.* 415, *dated* 30*th June* 1862.

I have the honor to inform the Committee of Directors that I have made trial of some coal forwarded by the Nerbudda Coal Company for experiment.

The coal was in large lumps, and was, when used, in good condition.

Four trips were run with it, three with passenger, and one with goods train. The results with passenger trains were so far favorable that time was kept, though the coal steamed very badly, and a large amount of ash and clinker were produced. The load, however, was light.

The result of the goods trip was very unfavorable; the engine steaming so badly that two hours were lost with the train, and the consumption of coal per mile was very high.

The three trips with passenger trains were made between Bombay and Campoolee, but the goods train was run to Khurdee, which road is much heavier.

It appears from these results that the coal may be used for light work, but that, when a large amount requires to be burnt in a given time, that it fails, probably from the amount of dirt in it.

This may be got over by running lighter trains, or using larger engines; but as it is entirely a question of economy, I am as yet unable to fix a point where the coal should be used, as it cannot be at present delivered on the Railway, except at an exorbitant price.

I have requested to be furnished with the price for which the Coal Company would supply the Railway, but the only price named is one for coal to be now delivered at a point on the unopen line, about 260 miles from Bhosawul, for Rs. 10 per ton, or at the pit's mouth for Rs. 6.

It is hardly necessary for me to offer any remarks on so wild a proposal, especially as the price is so high. But whatever the price was, it would be inexpedient to buy coal which we would not use for three or four years, and which we should have no means of securing.

Such a plan would, no doubt, suit the pockets of the Coal Company, but would not pay us. But Mr. Blackwell adds that, although the Nerbudda Company would be willing to enter into a contract now for 10,000 or 20,000 tons at the price stated, and to stack it ready for the use of the Railway when opened, yet "they would not be at all inclined to make a contract at such a price for future delivery." In answer to this, I must say that I do not think that it would pay to carry the coal as far as Bhosawul, and that the price must be reduced to enable it to compete with English coal.

In forming this opinion, I am not only guided by the evaporative power of the coal, but have taken into consideration the increased train mileage and reduced efficiency which will result from using an inferior fuel.

In the Table annexed, I have added the results of the working of engines with English coal, neither the men nor coal being picked.

The quantity experimented on was too small to get a fair figure for the evaporation.

Table showing the results of trials with Nerbudda, West Hartley, and Brymbo Coal.

Name of Coal.	Date of trial.	Name of Driver.	Number of Engine.	Train miles run.	Coal consumed in cwts.	Wood consumed in cwts.	Fuel in lbs. per train per mile.	Average load.	Fuel in lbs. per vehicle per mile.	Refuse. Ashes in cwts.	Refuse. Clinkers in lbs.	Remarks.
Nerbudda	March 12 ...	R. Walker...	29	146	43½	2	3·49	17·	2·05	9	112	Passengers train.
Ditto	„ 12 ...	Russel ...	15	146	41¾	2	33·35	15·	2·24	9½	40	„ „
Ditto	„ 14 ...	„ ...	15	146	41½	1	32·6	21·	1·55	10½	108	„ ,
Ditto	April 7 ...	Gilbert ...	62	137½	83	2	69·23	32·	2·16	12	500	Goods train.*
West Hartley	March 12 ...	Russel ...	15	146	32¼	2	26·27	18·	1·46	2	28	Passengers train.
Ditto	April 8 ...	Gilbert ...	62	137½	49½	1	41·13	33·7	1·22	5½	28	Goods train.
Ditto	„ 9 ...	„ ...	62	137½	48½	1	40·32	33·4	1·2	3	28	„ „
Brymbo	„ 16 ...	Abott ...	56	137½	57	1	47·24	37·1	1·27	4½	82	„ „
Ditto	„ 18 ...	„ ...	56	137½	53	2	44·8	36·1	1·24	3½	56	„ „

* In this case the driver lost two hours going down, owing to the coal steaming badly.

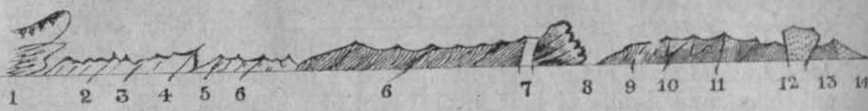
No. 3558, dated 13th September 1862.

Endorsed by the Public Works Department.

Copy forwarded to the Officiating Chief Commissioner Central Provinces, for any remarks he may desire to offer on the subject.

ANNEXURE C.

Section in Sitariva Glen.



1.—The conglomerate of the Mahadeva group, nearly horizontal, overlies unconformably the Lower Damuda rock.

2.—50 feet of *grey* thick bedded sandstone, with bands of red and blue shale; dip 15° E. 5° N.

3.—10 feet of coal.

4.—30 feet of hard grey micaceous flagstones.

5.—16 feet: seven feet grey and blue shales; two-half feet earthy coal; one-half feet sandy grey shale; five feet coal; dip 25° E. 35° S. From five to seven 180 feet of sandstone flags, some being hard micaceous, and some coarse and friable, and some bands pebbly.

6.—Places where shales occur among the above; at both the shales are very carbonaceous, and at one there is a thin layer of coal; in both the shales contain vegetable impressions.

7.—A trap dyke.

8.—A break in continuity may be caused by a small fault.

9.—Green mud and earthy sandstone, boulder bed, and conglomerate. Dip irregular, but reversed to the north.

10.—Trap dyke probably marks a small fault; the beds to the north of it dip at a much higher angle than those to the south. These seem to be the same; both are earthy sandstone.

11.—Coal four feet. Close to this coal band a bed of brown earthy sandstone abounds with glossopteris and phyllotheca; some blue and grey shales are associated. These beds are vertical.

12.—The above beds pass on into other similar strata, which begin to dip south.

13.—The same beds apparently now dipping north.

14.—Trap laying against them.

ANNEXURE D.

Report on samples of Coal from Australia, the Nerbudda Valley, and Nagpore. By R. HAINES, ESQ., *Acting Chemical Analyser to Government Bombay, dated* 12*th July* 1860.

The Australian coal is jet black and brilliant, very brittle, and breaks with a cubical fracture like Newcastle coal. The Nerbudda coal is dull black, heavy, very hard, being pulverized with difficulty; it has a laminated structure and slaty cleanage; interspersed in its substance are seen here and there small lumps of half formed coal like charcoal. The Nagpore coal is very similar in appearance to the Nerbudda coal, and has the same texture, except that the lamina are alternately dull and glossy.

The most noteworthy results of the analysis are indicated in the following table, and analysis of Welsh, Scotch, and Newcastle coal are added for the sake of comparison :—

Description or locality of coal.			Specific gravity in lumps.	PER CENT.					
				Coke.	Coke after deducting ash.	Volatile matter.	Volatile matter deducting ash.	Ash.	Sulphur.
Australia	...	...	1·312	68·27	59·89	31·73	40·11	8·38	·50
Nerbudda Valley	...	...	1·440	66·63	48·54	33·37	51·46	18·09	·60
Nagpore	...	...	1·417	76·00	37·27	24·00	42·73	18·73	·34
Wales	from	...	1·275	62·5	...	37·5	...	1·25	·33
Steam coal,	to	...	1·350	88·1	...	11·9	...	6·94	5·07
		Average, about	1·31	80·	...	20·	...	3·	1·25
Scotland,	from	...	1·200	49·30	...	50·70	...	1·13	·33
	to	...	1·316	59·15	...	40·85	...	14·57	1·57
		Average, about	1·26	54·	...	46·	...	4·	1·1
Newcastle,	from	...	1·23	62·7	...	37·3	...	·20	·06
	to	...	1·31	72·3	...	27·7	...	13·91	1·85
		Average, about	1·28	66·	...	34·	...	4·	1·

The Australian coal is bituminous, and cokes like Newcastle coal. The Nerbudda and Nagpore coals do not even sinter together in coking; they would appear, therefore, to be not well suited for that operation. The ash of the Australian coal was of a dirty white color, and the table shows it to be rather abundant; that of the Nerbudda and Nagpore coals is much the same in appearance, but in very large proportion, and its abundance by clogging the fire bars must detract a good deal from the utility of the coal independently of the loss of the carbonaceous matter, whose place it occupies. The sulphur in all three specimens is in moderate proportion.

One of the most important elements in the determination of the value of a fuel is, of course, a knowledge of the heat which it produces in burning. Accurately to ascertain this requires the use of a peculiarly constructed apparatus, fitted to absorb the whole of the heat given out by the combustion of a known quantity; but in default of this, a very good approximation may be obtained by the method introduced by Bertheir of fusing it with litharge—the quantity of lead reduced by the fuel furnishing a measure of its heating power. The result of this method is given below from a mean of two assays for each, together

with a view of the calculated heating effect with regard to water. But as it is impossible to utilize the total quantity of heat produced, a large portion escaping with the draught, and much being lost by radiation, a large allowance must be made in forming an estimate of the practical value of the fuel. The loss varies, according to the arrangement of the boiler and flues and the management of the fire, from one-half to one-fourth, but is seldom reduced to so low a proportion as the latter,—the average evaporation effected being something less than two-thirds of that of which the fuel is theoretically capable.

A comparison is made with British coals as in the former Table :—

Description or locality of coal.	Lead reduced by one part of coal.	Pounds of water raised from 80° to 212° by 1lb of coal.	Pounds of water evaporated from 212° by 1 lb. of coal.	
		(Theoretical.)	(Theoretical.)	(Practical) Estimated.
Australian	21·64	66·69	9·09	5·64
Nerbudda Valley	17·46	53·81	7·33	4·54
Nagpore	20·83	64·20	8·75	5·42
Wales, steam from	28·92	89·07	12·18	7·55
Coal, to	34·06	105·00	14·36	8·91
Average, about ...	31·0	95·5	13·02	8·07
Scotland, from	24·32	74·90	10·24	6·35
to	28·38	87·41	11·94	7·40
Average, about ...	25·5	78·54	10·71	6·64
Newcastle, from	28·80	88·70	12·13	7·52
to	31·86	98·13	13·42	8·33
Average, about ...	30·0	92·4	12·60	7·81

ANNEXURE F.

List of the principal out-crops of Coal in the Baitool District.

1. RAWUNDEO, on the Tawa River, near Salyia (see detailed description of this section, ante page 1540,) 21 feet two inches of coal are seen in eight distinct out-crops; but, inasmuch as some of these out-crops may be different parts of the same bed, brought again to the surface by faults, it cannot be proved that the total aggregate thickness exceeds 10 feet 8 inches. This section has not been before described; it was first examined by the Survey in 1856. The coal is excellent in many of the beds, and the average thickness of three feet, which is attained by the coal at four of its out-crops at least, together with the low dip which the beds have, will afford facilities for "*getting*" the coal cheaply when it comes to be worked.

SHAPUR, on the Betul and Hoshungabad road, is about 12 miles from the spot, and a branch road could easily be constructed. The place is, however, far from the Nerbudda Valley.

2. MACHNA, near Kotri and Murdanpur villages, seen on the bank of the Machna river; there are two seams, one six inches thick, shaly and impure; the other, three feet thick, dips at an angle of 30° at the out-crop, and is of excellent quality. It comes to the surface about three miles from Shapur (on the Betul and Hoshungabad road), and is thus

more accessible than at Rawundeo, to which, however, in all other respects it is inferior.

3. SONADI, in the Bora Nudi; two bands exist, 19 and 10 inches thick respectively. This locality, mentioned by Colonel Ouseley, was successfully worked by Mr. Johnston, under the orders of Sir R. Hamilton, of Indore. He sunk a shaft, besides cutting back on the out-crop, and found the coal of good quality. Some of it sent to Bombay for trial was found to be in many respects excellent, though much injured by the mode of carriage. The Sonadi coal has since been examined by Mr. Jacob and others, whose reports contain much information.* The out-crop is not more than six to eight miles from the Betul and Hoshungabad Road.

* Selection from Records of Bombay Government, No. XIV.

4. SOOKI NULLA; near the junction of this stream with the Tawa two thin seams of coal are seen, three inches and two and a half inches thick respectively. They rapidly die out to mere threads and patches among the false bedding of the sandstone. A far too favorable view of this place has been taken by previous observers. Mr. Johnston was of opinion that it might be worked profitably.

5. MORUN RIVER, near Lokurtully; a three feet seam of poor pyritous coal out-crops in the river bank, with a very slight dip, first noticed by the Survey in 1856. Any importance attaching to this locality is derived from the fact of its being the most westerly of all the known out-crops. The Sonadi coal passed near this place on its way to Bombay, and before getting thus far, was carried on buffaloes more than 30 miles over bad hill paths. The Lokurtullye coal is easily approached from, and very little above, the level of the Nerbudda Valley.

6. BORI VALLEY.—Thick beds of carbonaceous shale, with many threads of coal, as seen at out-crop; it is not workable.

ANNEXURE G.

Report on the Coal seams of the Tawa Valley in the Baitool District, Central Provinces. By W. T. BLANFORD, ESQ., *Deputy Superintendent Geological Survey of India, dated 4th April* 1866.

The coals of the Tawa Valley have frequently been reported upon; the last and most complete account of them being that given by Mr. J. G. Medlicott, of the Geological Survey. Full details of the different seams are given in the body of his report—"On the geological structure of the central portion of the Nerbudda District" (Memoirs of the Geological Survey of India, Vol. II.,) or in the Appendix, page 268.

The principal localities described were the following :—

1.—Rawundeo on the Tawa River, 21 feet 2 inches of coal seen in eight distinct out-crops, besides some repetitions. Two of the seams are four feet at least in thickness at their out-crops.

2.—Murdanpur and Kotti on the Machna, a tributary of the Tawa, two seams,—one three feet thick, the other six inches only.

3.—Sonadi on the Bora Nuddi, another tributary, two seams—19 and 10 inches thick respectively.

4.—Sooki Nuddi, a third tributary, two thin seams three and two and half inches thick respectively; and, of course, worthless. Besides these, there are two seams—one two feet three inches thick, and a lower seam of three inches, occurring on the Machna river between Shapur and Murdanpur, mentioned in the detailed section at page 160, but not referred to in the Appendix, being probably considered by Mr. Medlicott merely a repetition of the Murdanpur out-crops.

No new localities have since been discovered, so far as I can learn. I received information from a Native of the occurrence of "kala patthar" near Kesla, which would be an important locality, being within 12 miles of the Railway, while the nearest known out-crop of coal is double that distance; but, on visiting the spot, I found the "blackstone" indicated to be a sandstone.

But although no new localities have been met with, the progress in our knowledge of the coal-bearing rocks of India during the 10 years which have elapsed since Mr. Medlicott examined the Tawa Valley has been so great, that it appeared possible that some additional particulars might be noted, and that a better idea of the mining prospects of the locality could be formed. In this anticipation I have not been wholly disappointed, although I regret to say that the result of my examination is to induce me to take an even more unfavorable view of the coal seams of the Tawa Valley than Mr. Medlicott did. I doubt if a single seam is known to occur in the valley which could be mined to any depth with profit under existing circumstances; and with one possible, but very dubious, exception, I am decidedly of opinion that no seam could be worked under any possible circumstances. The possible exception is in the Rawundeo section, to which Mr. Medlicott particularly called attention; but there are some peculiarities connected with the seams there found, which make me think their availability for mining purposes doubtful.

In order to show my reasons for the unfavorable opinion formed, I shall proceed briefly to describe the several localities. It must be remembered that these are all out-crops exposed in nullas, and that the sand in the bed of the nullah shifts from season to season, exposing portions of rock and out-crops at one time, which it conceals at others. This is especially the case with these coal seams which usually underlie beds of coarse sandstone; and the latter, being hard, stand up in small terrace-shaped masses, against which the sand accumulates, concealing the softer coal beds beneath. For this reason it is improbable that any two successive observers will see exactly the same section if they visit it in different years; and in some cases I was unable to find again seams mentioned by Mr. Medlicott, and, *vice versa*, I saw some which he, I believe, did not.

1. Sonadi.—I saw coal in three places here; Mr. Medlicott only in two. The highest seam is about 19 inches thick, with four or five inches of shale overlying it, and upon this coarse sandstone. All other

seams are thinner; the second seam in descending order is 10 inches thick, with a roof of coarse sandstone. Beneath this comes—

	Feet.	Inches.
Coarse sandstone	10	0
Coal	0	6
Shale and shaley sandstone	4	0
Coal	0	8

About 100 yards farther south another seam occurs, about one foot six inches thick, of coal and shale mixed. The roof here also is of coarse sandstone.

2. Sooki Nulla.—Only strings three or four inches thick occur as noted by Mr. Medlicott.

3. About two miles east of Shapur, on the Machna river, a seam, two feet three inches thick, is seen associated with shale, and a lower seam, three inches thick, as above mentioned. The upper seam can be traced a short distance—about 100 yards.

4. Murdanpur, on the Machna.—Mr. Medlicott saw two seams here, one was probably concealed by sand at the time of my visit, but it was only six inches thick. The other amounts to three feet in places, but is extremely variable. The roof is again coarse sandstone; the seam is seen for several yards along the south (right) bank of the stream, but is not seen, where, if continuous, it should recur on the north bank. It is possible that there may be a fault, but I could find no indication of one. It appeared to me that the associated sandstone re-appeared without the coal seam, and my impression was that the latter had thinned out and vanished completely.

5. Rawundeo, on the Tawa River.—A careful description and a measured section of this locality are given by Mr. Medlicott at page 154 of the Memoirs. Yet such changes have been produced by the stream in 10 years, that I had much difficulty in recognizing several of the beds, I believe the rocks in the upper part of the section to be better exposed, on the whole, now than they were in 1855, while the lower portion is now comparatively concealed. I counted 11 out-crops of coal; Mr. Medlicott 13 (of which he considered several to be repetitions caused by small faults). At the same time he mentions that there was no clear evidence of faulting. I certainly do not think there is any in the upper part of the section; and I think, so far as the number of seams exposed is concerned, that he has under-rated the resources of the spot rather than otherwise. Some of the coal is of excellent quality, and one or two seams are four feet thick in places at all events.

On the other hand, the roof is frequently, though not always, coarse sandstone. The seams are not of even thickness throughout—some, perhaps all, being very variable. The most of them are only seen for a few feet, and in only two cases could I trace them the whole distance across the river. One so traced varied but slightly in thickness, being about one foot to one foot three inches; the other was two feet thick in one bank of the stream, and gradually thinned away, and vanished completely before reaching the other bank—less than 50 yards distant. Both these seams were associated with flags and shales.

It will then be seen that, except at Rawundeo, not one seam is known to occur exceeding three feet in thickness, and I doubt if any seam of that thickness can be profitably mined in India. I am aware that much thinner seams are worked in England, some, I believe, not exceeding 18 inches, though that is exceptional. But in England there are three advantages at least which are wanting in India. These are—

I.—A large local demand.
II.—Excellence of quality.
III.—A skilled mining population.

In India, in a place like the Tawa Valley, there is no local demand, nor is it very probable that there ever will be. The best Indian coal from the Damuda beds is about half as good as the *best* English coal, that is, if used in a steam engine, for instance, it takes twice as much Indian coal to do the same work. The value consequently, weight for weight, is about one-half; and a three feet seam of Damuda coal is, on this account alone, only an equivalent of an 18 inch seam of English coal. Another disadvantage entailed by the inferiority of quality is, of course, increased expense for carriage.

The want of skilled labor causes more coal to be cut to waste, besides largely increasing the cost of superintendence.

Taking all the disadvantages into consideration, my own impression is that, from four feet six inches to five feet is the minimum thickness of a coal seam which can be profitably mined in India under ordinary circumstances. In the immediate neighbourhood of a Railway, or of any other large source of demand, perhaps rather thinner seams might be worked.

I do not mean to say that a considerable quantity of coal, some thousands of tons in many cases may not be profitably extracted from thinner seams near the surface. I merely refer to regular mining, involving the erection of machinery and other heavy expenses.

Of course, too, the conditions of the profitable mining of Indian coal depend upon a variety of circumstances liable to change. A mining population might gradually spring up; the demand for fuel may, and probably will, increase, while other supplies may fail, or increase in value to such an extent as to raise the price of the article permanently. These other supplies at present are wood and English coal, either of which may at any time become unprocurable. On the other hand, if India ever attains a civilization at all approaching that of Europe, it will undoubtedly grow timber for fuel largely, as is done in all other civilized countries not rich in coal. At present, the principal efforts of the whole Native population appear to be devoted to the destruction of the forests, and it is but fair to say that their labors have been rewarded with great success.

Supposing, however, that seams of four feet in thickness could be worked, or that two or three seams were mined from one shaft, thus diminishing the cost of sinking and of machinery, there appears a possibility that the Rawundeo coal might be mined, especially as the quality is, in some seams, exceptionally good. But there is still one point which must be satisfactorily determined before the seams could be pronounced workable, and that is the question how far the seams can be trusted to be constant in thickness.

Where merely small sections are seen in the banks of rivers, not extending frequently more than five or six yards, this question is difficult to answer. Of all the seams seen in the Tawa, Machna, and Bora streams, the out-crops of not more than three or four can be traced for 50 yards, and out of these few, one, in the Tawa, dwindles from two feet to nothing in that distance; and a second, at Murdanpur, on the Machna, appears to do the same, and certainly, out of a total of barely three feet varies as much as a foot within 20 yards. Moreover, nothing is more common than to find coal seams of variable thickness when their roof consists of coarse standstone; it appears always to mark slight local unconformity, and denudation of the coal seam beneath. But in the case of the seam at Rawundeo, which is seen to thin out, its irregularity is not due to this cause, the roof being of flaggy sandstone.

In describing the Raneegunge coal field, I showed that there were two subdivisions of the coal-bearing rocks, or Damudas, the lower containing numerous coal seams of great size, but so variable in quality and thickness that it was doubtful if any could be largely mined. The beds were characterized by frequent alterations of shales, flaggy beds, and massive sandstones. In the higher sub-division of Raneegunge beds, the alternations were less numerous, the several beds much thicker, and the coal seams more constant. I am inclined to believe that the beds of the Tawa Valley resemble those of the Lower or Barakkar series of the Raneegunge field in the peculiarities of the coal seams, as they certainly do in their position at the base of the coal measures.*

A very important and interesting question is the probability of the occurrence of coal in the more northern portion of the Tawa Valley, near Kesla and *Bagra*; in the first place, because coal occurring there might belong to the higher and richer beds; and secondly, because it would be so much nearer to the line of Railway. Time did not allow me to examine the valley thoroughly, but a cursory inspection of the neighbourhood of Bordha and Kesla induce me to believe that the rocks there occurring are very possibly lower in position than the true coal-bearing beds of the Damudas.

From COLONEL A. P. PHAYRE, C. B., *Chief Commissioner of British Burmah, to the Secretary to the Government of India* HOME DEPARTMENT, *Simla,—No.* 303, *dated Thayet-Myo, 20th September* 1866.

I have the honor to acknowledge the receipt of docket No. 881, dated the 15th of May last, from Mr. Under Secretary Arthur Howell, forwarding copy of despatch from the Secretary of State, No. 29, dated the 24th March last, on the subject of coal resources and production, and requiring a report thereon supplemental to the report by Dr. McClelland of the 11th July 1865.

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* It is possible that the Mopani beds, which however I have not seen, belong to the Upper or Raneegunge series, as do I think some, and perhaps all of the Pench beds also.

2. The province of British Burmah consists of the former separate divisions of Tenasserim, Pegu, and Arracan. The coal resources of the two first named divisions have formerly been thoroughly reported on by Dr. Oldham. I am not aware of any fresh discovery of coal, since the date of those reports, within the limits of those divisions. It would be presumption in me to attempt to produce a report upon this subject derived from the writings of Dr. Oldham; I will, therefore, here merely refer to them.

3. The volume of Selections from the Records of the Government of India (Home Department) No. X., published in 1856, from pages 30 to 107 inclusive, contains the whole of the reports and observations regarding coal discovered in the district of Mergui, Tenasserim division, and near the station of Thayet-Myo in the district of Prome, Pegu division. I am not aware of coal having been discovered in any other localities of those two divisions than those mentioned in that volume.

4. With reference to Arracan, the report by Dr. McClelland includes, from pages 128 to 133 inclusive, all the localities where coal had, up to the date of that report, been discovered in that division. Since then, I believe, that coal has only been discovered in one locality not before noticed. That is, in the bed of the Byeekhyoung stream, about six miles from the town of Sandoway. This was reported by Mr. H. W. Beddy, who visited the spot in November 1862. It was found at the surface, and was not dug for. About 80lbs. weight were brought away, and the coal was reported on by Mr. W. Dunn, Civil Engineer at Akyab. I beg to submit a copy of his report.

5. In conclusion, I beg to observe that the coal districts of Arracan have never yet been reported on by a geologist. With reference to the remark of Dr. McClelland that the discoveries made "unequivocally prove the existence of large beds of coal in this province," I would beg to recommend that a geologist may be sent to inspect and report upon the several localities where it has been found.

Report on Coal, by W. DUNN, ESQ., C. E., *dated* 28*th January* 1863.

With reference to the specimen of coal forwarded for report, it is impossible to give a concise or correct analysis of the mineral, or the illuminating power of its gas, in consequence of the want of retorts, photometer, barometer, &c.; but from a careful examination of the specimen forwarded, and of the fracture shown when broken, I am led to conclude that it is a kind of brown coal or lignite, somewhat closely resembling the splint coal. It contains a large quantity of bitumen, which would yield volatile carburets when distilled; texture, fibrous: burns with a clear flame, and gives out, when burning, a peculiar bituminous odour.

The specimen forwarded has evidently been long exposed to the influence of the atmosphere; and I think that, if careful borings were taken, a large bed would be discovered of a more dense and heavier quantity, which would be invaluable in smelting iron ore or copper, and would undoubtedly make a first class coke for locomotives, or would

be well adapted for steam-boilers, although the specimen examined required a rather high temperature to ignite it.

From Sir G. U. Yule, C. B., K. C. S. I., *Resident at Hyderabad, to the Secretary to the Government of India* Home Department, *Simla,—No.* 35, *dated 9th August* 1866.

With reference to Government memorandum No. 882 of the 15th May 1866, with enclosure, calling for a report on the coal resources and production in the districts, I have the honor to forward, for the information of Government, copy of a letter from the Officiating Commissioner, Hyderabad Assigned Districts, No. 725 of the 27th ultimo, with enclosures, relative to the coal discovered in the Woon district, and to state that I had the coal tried at Hyderabad by a blacksmith, and found that it burned with great difficulty, gave out very little heat, and left an enormous proportion of ash.

2. No trace of coal has been found in any other part of the Hyderabad Assigned Districts.

From Major W. Nembhard, *Officiating Commissioner Hyderabad Assigned Districts, to the* 1*st Assistant Resident,—No.* 725, *dated Ellichpore,* 27*th July* 1866.

With reference to your letter No. 1016 of the 8th June last, I have the honor to forward copy of a letter* from the Deputy Commissioner Woon, being a further report upon the coal found in his district. It is now very desirable that the spot where the vein is said to be, should be examined by some professional coal-viewer. Since receipt of the report now forwarded, I have learnt from Lieutenant Hudleston that the coal discovered in the Chandah district of the Central Provinces is just opposite Lieutenant Hudleston's discovery, and probably they are one and the same vein.

* No. 654 of 17th July 1866.

2. With advertence to your No. 926 of the 28th May 1866, I have the honor to state that the Deputy Commissioners Oomrawuttee, Akolah, and Mehkur, report that there are no traces of coal in their districts.

From Lieutenant R. Hudleston, *Deputy Commissioner Woon District, to the Commissioner, Hyderabad Assigned Districts,—No.* 654, *dated* 17*th July* 1866.

In compliance with your Financial circular No. 37, dated 4th June 1866, calling for a report upon the coal resources of this district, and also, with reference to your Financial No. 42, dated 19th June 1866, regarding the result of the examination of the coal found in this district, I have the honor to state that, early in the present year, coal was discovered near the village of Koombari, upon the River Wurdah, a few miles above its junction with the Painguuga.

2. A small specimen was sent to Madras by post, and the result of the analysis is given as Appendix No. 1 to this letter.

3. I also forwarded about 60 seers to the Agent of the Great Indian Peninsula Railway for trial in a locomotive, and I annex a copy of a letter from that Officer's Secretary, as Appendix No. 2.

4. From these documents it is clear that the quality of the coal forwarded is inferior; but, within the last few days, I have visited the locality, and a personal inspection leads me to the opinion that there is a superior, or at any rate a different, kind of coal to be obtained.

5. I found the coal in the gravelly bed of the nullah from five to seven feet below the surface, according as the excavation was made higher up, or lower down, towards the river Wurdah. The banks of the nullah being some 30 feet high, I was unable to ascertain the breadth of the vein, nor am I able to state further than that, for some 200 yards, a solid and even bed of coal lies at a depth of some few feet from the surface of the bed of the nullah.

6. My reason for believing that there is a variety in the quality of the coal is, that a sample which I obtained by digging to a somewhat greater depth higher up the nullah, is blacker in appearance, and less stony looking, more easily broken, and lighter than the specimens I previously forwarded.

7. Mr. Blanford, of the Geological Survey, is, I understand from the Deputy Commissioner Chandah, expected to visit the vicinity in the cold season; and I would recommend that he be instructed to cross the river and report upon the Koombari vein.

8. The proposal of the Railway Agent to send some 20 cwts. of the coal to Bombay would cost Rs. 250 or Rs. 300; and I do not recommend its adoption. With your permission I shall, however, forward a specimen of, what I believe will be found, a better quality of coal for analysis at Madras.

Demi-official letter from S. J. WYNDOWE, ESQ., *to Doctor* BALFOUR,—*Dated St. Thome, Madras, 26th April* 1866.

I have much pleasure in sending you the following results of my analysis of the specimens of coal sent by you :—

Specific gravity	1·53
Percentage—Volatile matter in part illuminating ...	23·5
" —Coke, or rather a substance retaining the appearance of the original mineral ...	7·65
" —Ash, after complete oxidation	33·
" —Sulphur	5·2

I append, for your information and comparison, analysis of good English coal, average specimen—

Specific gravity	1·273
Percentage—Coke	57·22
" —Volatile matter	42·78
" —Ash	1·03
Sulphur	39.

The small quantity sent by you was not sufficient for me to test its value as fuel by direct experiment, but the analysis is sufficient to show it would not be of much value. Perhaps a better specimen than the one sent by you might be obtained from the same locality.

From H. J. P. THOMSON, ESQ., *Secretary to the Agent Great Indian Peninsula Railway Company, to the Deputy Commissioner Woon District,—No.* 2948, *dated Bombay*, 31*st May* 1866.

With reference to your letter No. 167 of the 21st instant, I regret to inform you that the quantity of coal sent was too small to be experimented upon, and it is stated by our Locomotive Superintendent to be of a very inferior quality. If you can send 20 or 30 cwts., at your own expense, we shall be glad to try it.

From T. OLDHAM, ESQ., LL. D., *Superintendent of the Geological Survey of India, to the Secretary to the Government of India* HOME DEPARTMENT,—*No.* 557, *dated* 26*th January* 1867.

I have the honor to submit herewith a brief memorandum on the *coal resources and production of India*, being return called for by the Right Hon'ble the Secretary of State for India, despatch No. 29, dated 24th March 1866.

I have at the same time to state the causes which have led to the delay in submitting this return.

So far as any general statement bearing on the question of the resources of India in coal was concerned, it would have been in my power to have submitted such a return in a few days after the receipt of your letter. But, as regarded the other branch of the enquiry, namely, the production of coal in India, or the out-turn from the several collieries worked in India, much greater delay was unavoidable. I have, as you are aware, already on several occasions pointed out the difficulty of procuring such returns in any case, and the impossibility in many cases, excepting by personal application on the spot. Up to the present time no systematic compilation of the mineral statistics of this country has been attempted continuously. In this, as in every other similar enquiry, investigations of this nature at the first excite jealousy of interference and dread of ulterior objects, which often prevent the required information from being given. In 1860, when the Geological Survey were engaged in the examination of the most important of the Indian coal-fields, that of Raneegunge, I took advantage of the opportunities which the progress of our Survey gave to obtain returns of the amount of coal raised at all the pits or quarries then worked. This, however, was successfully carried out only after considerable care in explaining the object of the inquiry, and after repeated and personal communication with the several proprietors. From the more important of these we received willing aid and ready co-operation, after the object was explained; while in other cases the calculations were made by the Survey Officers themselves on the spot.

Having completed the survey of this field, full returns of the coal raised in India during the years 1858-59 and 1860 were published in the papers of the Geological Survey. (Mineral Statistics, I., Coal, Vol. III.) It was then hoped that similar statistics would continue to be carefully compiled and published annually.

In the present instance, immediately on receipt of copy of the despatch of the Right Hon'ble the Secretary of State, I addressed a

circular to the several Companies and others engaged in coal-mining, soliciting the favor of their giving me the necessary information to enable me to compile returns for the years subsequently to 1860, (the date of the last return published), similar to those which they had contributed before. To this application I have received prompt and full replies from many of the principal proprietors, for which I am much indebted; by others the returns have been promised, but have not yet been received, while from several I have had no reply whatever.

I was very desirous of completing these returns up to the close of the present coal year, which, from old custom originating in the peculiar mode of transport in use in the Raneegunge field previously to the completion of the East Indian Railway, is generally taken to close with the month of October; and I therefore deferred till after that date the submission of these returns. Since then I have in every way endeavoured to expedite the preparation of these statistical statements of the out-turn of coal in India. Some of the returns only reached me yesterday, and I shall probably obtain others; but I cannot longer delay the submission of those now given, although still compelled to leave them incomplete. Should further returns be received, I shall submit them as supplementary to the present.

I would again take this opportunity to urge that no trustworthy statistics of the production of coal in India, or of any other mineral produce, can ever be effectively compiled unless the enquiry be carried on systematically and continuously from year to year. And for years to come, it will also be essential that the Officer charged with such compilation be able to visit the several localities from time to time and confer personally with the several proprietors and agents. If the collection of such statistics be entrusted to one who is competent to advise in mining matters, I would anticipate that much mutual benefit to the mining proprietors, as well as to the public, would be the result.

In the absence, however, of any such systematic enquiry as I had desired, and as I again urged in immediate connection with this present report (my letter to your address, No. 470, dated 3rd June 1866) I am only able to submit the present returns, knowing them to be incomplete.

The "Coal resources and production of India," by T. OLDHAM, ESQ.

I. COAL-FIELDS OF INDIA.—Viewed as a coal-producing country, the British territories in India cannot be considered as either largely or widely supplied with this essential source of motive power. Extensive fields do occur, but these are not distributed generally over the districts of the Indian Empire, but are almost entirely concentrated in one (a double) band of coal-yielding deposits which, with large interruptions, extends more than half across India from near Calcutta towards Bombay. This band extends throughout about five degrees of latitude.

A simple mode of representing this graphically, and of showing at the same time the area from which supplies of coal may be looked for with any prospect of success, without complicating the question with

details of minor importance, is to indicate generally on a map of India those portions of the country of the geological structure of which we have sufficient knowledge to enable us to assert that there is no probability whatever of any deposits of coal being found within their limits, or where, if coal do exist, it must be found at such depth below the surface that it could not be economized. This I have done on the accompanying small map of India.

It will be seen from this that all the area lying to the south of the 20° parallel of latitude is without any known coal, or any probability of its existence, and similarly that all the country lying to the north of the 25° parallel up to the foot of the Himalayas is under similar conditions. (In this general statement the widely detached coals of Eastern Bengal, Assam, and Khasia Hills, and the poor coals of Tenasserim, are for the time neglected). As British India stretches from 8° north latitude to 35° or 36°, or through some 28°, the very local disposition of its deposits of coal becomes evident.

On the same map I have indicated also, so far as the very small scale will admit, the true limits and outline of those coal-fields which are known. Taking these two indications together, they will be sufficient to point out the very limited and localized area from which coal may be looked for in India, and therefore the vast importance of a careful investigation of these limits in area and the amount in quantity of such supplies as may be depended on.

Of a very large portion of these coal areas detailed examinations have been made. The Memoirs of the Geological Survey of India contain the following special reports, &c., besides the more general descriptive notices: On the Coal and Iron of Cuttack, Vol. I; on the Talcheer Coal-field, Vol. I; on the Khasia Hills, Vol. I; on the Nerbudda Valley fields, Vol. II; on the Raneegunge Coal-field, Vol. III; Mineral Statistics, Coal, Vol. III; the Coal of Assam, Vol. IV; the Jherria Coal-field, Vol. V; all with maps, &c. There have also been separately published; a Report on the Salt Range Coal; on the Coal at Lynyah in Sind; on the Pench River Coals, and other notices. Detailed reports, with maps, &c., of the Hazareebaugh Coal-fields—the Bokaro and Ramgurh fields—are now in hand, and will appear in spring; while preliminary examinations of the Singrowlie and Sirgoojah fields have been made, and the Geological Survey only waits the preparation of topographical maps to prepare detailed plans. The Belaspore or Koorbah field will be visited during the present working season, and also the reported coals near Chanda or in the Woon district. In addition to the above, the lignitic deposits near Murree and in several other places in the Sub-Himalaya regions, and the poor and limited coal deposits under Darjeeling, have all been visited and reported on; while in the distant provinces of Burmah and Tenasserim also all known coal deposits have been visited and reported on. This will be sufficient to show that the coal resources of India have received full attention from the Geological Survey of India under my charge. In many cases, it has been impossible to carry out any detailed examination, because no trustworthy maps existed. In these instances we had to adopt one or other of two methods, either to construct for ourselves such a sketch

map as might suffice for the record of our observations (as was done in the Nerbudda Valley), or to make at present only a general reconnoissance of the district, and wait till the progress of the regular Topographical Survey of the country gave us good maps before taking up any detailed investigation.

There still remains, however, much to be surveyed, and until careful mapping has been carried out of all the fields, any estimate of the coal resources and production of British India must be defective. The want of even preliminary investigation affects the questions referred to me in a broad way; while, on the other hand, when we attempt closer detail, and endeavour to arrive at any satisfactory conclusions as regards the actual supplies of fuel available in the separate districts or fields, we are met by the want of detailed sections or sinkings or workings. Up to the present time it may be said that little more than surface workings have been carried on in India. The deepest pits in this country scarcely exceed 75 yards, while certainly one-half of the Indian coal, which has been used up to the present date, has been produced from open workings or quarries, in which the coal has been worked like any ordinary stone. In parts of the Raneegunge Field these open workings are of marvellous extent and size, covering hundreds of acres.

Many causes have combined to lead to this mode of working. Cropping out at the surface with a very small dip, and, in most cases, with a very limited covering of clay or rocks, the valuable mineral could be removed at a very small cost. No expense was incurred for lights; drainage was easily and cheaply effected; *all* the coal was obtained, and the heavy waste incurred in cutting or hewing brittle coals, such as are most of the Indian coals, was avoided. But even more than all these considerations, the facility of obtaining labourers who would work in the day-light, and the difficulty, or even impossibility, of procuring those who would work in a pit, combined with the ease of inspection and measurement in one case, and the cost and difficulty in the other; all led to the vast extension of open-work quarrying of coal, and, consequently, to the economy with which the mineral could be obtained and sold.

This system is rapidly disappearing. Much of the coal accessible in this way has been removed, while at the same time the managers and proprietors are daily becoming more alive to the injudiciousness of exposing valuable seams by these diggings towards the outcrop. Every year is also adding to the number of labourers, and also of the tribes or castes to which they belong, who will work under-ground.

But even in the only Indian coal-field which has yet been worked to any extent—the Raneegunge field—very much more must yet be done before safe and satisfactory conclusions can be reached as to the amount of coal and its position.

Up to the last year or two, I am able further to state that in no single instance was a survey of the under-ground workings made or plans kept. The memory of the 'old men' was the only source from which information could be obtained as to the extent of the workings, the mode of occurrence of the seams, the disturbances to which they

had been subjected, &c. I am glad to say this system, or want of system, has been changed in some cases, and plans are now kept, certainly in one case, and I hope also in others. Considering the many ways in which danger to public safety (putting aside altogether the serious risks to private property and to individual life) results from abandoned mines and excavations, and from an ignorance of their true limits, I am compelled to think that the keeping and recording of such plans ought to be rendered compulsory. The cost to the colliery proprietors would be slight, while the advantages, even to them, would be inestimable. In hundreds of cases, the safety, nay the very possibility, of working certain mines or parts of mines will depend upon the accuracy of the knowledge of the limits of adjoining excavations, or upon sacrificing much valuable material by leaving unwrought greatly larger barriers that may be necessary. Such plans ought, I think, to be therefore insisted on, under penalties for neglect of this precaution.

Turning now to the fields actually known up to the present date in India, it will be most convenient to notice them briefly in the order of their successive geographical distribution, commencing with those nearest to Calcutta and proceeding westwards, taking first those which occur in the great band of coal-fields to which I have alluded above, and then briefly noticing separately those which are comparatively distant or isolated.

These fields are the following :—

1. Rajmehal Hills.
2. Raneegunge.
3. Kurhurbali.
4. Jherria.
5. Bokaro.
6. Ramgurh.
7. Karunpoora, North and South.
8. Ertcoora.
9. Palamow.
10. Sirgoojah : Singrowlie.
11. Upper Sone.
12. Koorba or Belaspore.
13. Talcheer.
14. Nerbudda and Pench River.
15. Chanda.
16. Kota.
17. Cutch.
18. Sind.
19. Salt Range.
20. Murree and other places.
21. Darjeeling.
22. Assam.
23. Khasia Hills.
24. Garrow Hills; Cachar.
25. Cheduba; Sandoway.
26. Burmah.
27. Tenasserim Provinces.

1. Rajmehal Hills.—Along the western side of the detached group of low hills which stretch from near Soory, the principal town of the Beerbhoom district, northwards to near the Ganges, and which are generally known as the Rajmehal Hills, coal deposits occur in many places. These localities may be readily divided into groups situated in the valleys of the streams which drain across this district. To the south in the basin of the Brahmini, four or five seams are known, varying in thickness from 3 to 12 feet. From some of these fair coal has been extracted in former years, but the absence of roads and the distance to which the coal must be carted before reaching any economical means of carriage prevent their being steadily economized. During the construction of the East Indian Railway, a considerable amount was extracted from some of these beds (see Mineral Statistics for 1858-61). The principal demand at that time being for brick and lime-burning, all

the coal, even of inferior quality, was most useful, and it was, therefore, profitable to cart it to the works so long as there was no other means of communication with the larger and better field of Raneegunge. But since the opening of the line of Railway, and the stoppage of the great demand created by such works of construction for inferior and small coal, these beds of the Rajmehal Hills have been abandoned.

In the valley of the Bansloi stream, further north than the Brahmini, several valuable beds of coal also occur. In the Goomani valley also, and towards the north-western end of the hill range near Borah, beds of coal occur, from which a very large quantity was extracted while the works of the East Indian Railway were being constructed. The same causes, however, which I have already referred to, led to the stoppage of all works in these localities as well as in the Brahmini valley, when the construction of the line of Railway had been completed.

Several projects were contemplated for opening up these deposits by increasing facilities of transport, but I cannot find that any thing has been done beyond the submission of crude projects. And notwithstanding the very large amount of money spent in these districts for several years, and the vast employment given to the people, nothing would appear to have been devoted in return even to the very first element of civilization, the construction and extension of roads through the country.

2. RANEEGUNGE.—This extensive and well known coal-field is at a distance of 120 to 160 miles north-west from Calcutta. It extends from a few miles to the east of the village of Raneegunge to several miles west of the Barakur, the greatest length being, nearly east and west, about 30 miles, and the greatest breadth, nearly north and south, about 18 miles. The area included by the coal-bearing rocks is about 500 square miles.

The field consists simply of a series of beds divisible into three groups, which have a general dip from the northern boundary to the south, at angles varying from 5° to 20°. Along the southern boundary the beds are turned up and all cut off by a great fault.

There is a total thickness exhibited by the series of rocks of more than 8,000 feet. And in this series there is a thickness of workable seams of coal of from 100 to 120 feet.

Towards the centre of the field, and forming also the hills of Beharinath, Panchet, &c., there rests unconformably on the coal rocks a series of beds of a more recent geological age and not containing coal. They entirely conceal the coal-rocks which are under them, and form a thickness of non-productive beds through which it would be impracticable profitably to work the coal at present. To this series the name of Panchet rocks has been applied. They contain some very interesting reptilian remains, and are probably of fresh-water origin, and of the general geological age of the Triassic or Rhætic rocks of Europe.

The Panchet rocks cover, say, one-fifth of the entire area of the field, leaving approximately 400 square miles over which the coal rocks are seen. It will be unnecessary to go into any details of the structure of the field, as a full descriptive report, with detailed map, has been pub-

lished for some time.(a) It will only be needful to indicate the fact that, so far as the experience derived from existing workings goes, it will be necessary to make very large deductions from any calculations of amount of fuel available in consequence of the proved irregularity and inconstancy of many of the seams.

The same reasons which induced the Geological Surveyors to avoid attempts to give any reliable statement of the absolute quantity of coal in this field when reporting on it in 1861(b) still remain, and any estimate now given will be open to the same chances of error, and must be considered only approximate. Taking the area of the field (omitting the portion covered by the Panchet rocks) as 400 square miles, and the thickness of coal as on the average, say, 30 yards, we would have an estimated thickness of $(400 \times 1760^2 \times 30) = 37,171,200,000$ cubic yards, or *roughly tons of coal.*

From this estimate it will be safe, from the reasons already given, *viz.*, the inconstancy and irregularity of the beds, to exclude one-half, leaving, say, 18,585,600,000, and deducting from this for waste, loss, small coal, &c., say one-fourth, we would have about 14,000 millions of tons of coal.

The coal of this field, like most Indian coals, is a non-coking bituminous coal, composed of distinct laminæ of a bright jetty coal, and of a dull more earthy rock. The average amount of ash is some 14 to 15 per cent. varying from 8 to 25 per cent.

The Raneegunge field has the advantages of two branches of the East Indian Railway, which traverse its richest portions, and afford great facilities for the removal of the coal. Until this Railway was constructed, the coal was all despatched by boats down the river Damudah. This was a very tedious and very uncertain mode of transport; this river is only navigable during freshets for a considerable part of the distance, and boats were often months before they reached their destination, while numbers were lost.

Unusual facilities exist for the construction of a navigation-canal from this river to the Hooghly river above Calcutta, and there can be no question that this coal-field and the others lying higher up the Damudah valley (and to which I shall presently refer) would yield a very large amount of traffic for such a canal. Its construction might also be made to control to a large extent the destructive floods to which the lower courses of the Damudah have long been known to be subject—floods which have led to an almost countless expenditure and loss, which may be prevented by controlling the rivers in their upper courses, but which can never be deprived of their dangerous and destructive character by any works in the lower portions of the same rivers.

3. KURHURBALI.—This small but valuable coal-field is situated to the north of the river Barakur, about 20 miles to the north-north-west of the prominent hill of Parisnath on the Grand Trunk Road near Topchanchy, and about 80 miles south of the Luckeeserai station of the

(a) Mem., Geol. Sur. of India, Vol. III. Art: I.

(b) loc. cit. p. 187.

East Indian Railway. It is of very limited extent, its greatest length not exceeding $6\frac{1}{4}$ miles, and its breadth nowhere being more than $2\frac{3}{4}$. The area of the coal yielding rocks altogether scarcely exceeds 10 square miles. In this field there are several beds of good coal of considerable thickness from 8 to 14 feet, and well placed for economical working. Much of this coal is also of better quality than the ordinary Indian coals, and therefore more valuable. This superior quality has been established, not only by assay, but by practical trials, continued over several months on the line of the East Indian Railway.

All the coal from this field up to the present time was necessarily carried on carts to the Ganges and the Railway. This involved a cartage over bad roads of some 80 miles, at a very heavy cost, and with great losses. Considerable expense also was incurred in opening up and maintaining the road. Notwithstanding all these drawbacks, it was (as in the case of the Rajmahal Hills already referred to) cheaper to cart this coal to the points where fuel was required than to use wood, previously to the opening of the Railroad from Calcutta. When this, however, was completed, the greater facility of transport at once reduced the cost of coal from the more distant field of Raneegunge, so that the carted coal from Kurhurbali could not compete with the rail-borne coal of Raneegunge. Other causes also combined with this difficulty of transport, and the working of this coal-field ceased for the time in 1863.

The recent commencement of the chord-line, which is to join the Raneegunge line of rail to the main line at Luckieserai, will again open out this small field. Unfortunately, even this chord-line runs at a distance of 25 miles from the nearest point of the coal-field, so that every wagon for coal will have to travel 50 miles (25 in and 25 out), in addition to the distance to which the coal must be carried on the line itself.

The Kurhurbali field has been worked to so small an extent that it is impossible to assert the equivalence or even the continuity of several of the beds. We may, however, I think, safely consider that we have an amount of coal equivalent to a thickness of nine yards over the field. From the total area, 10 square miles, we must deduct, say, one-fifth, over which the overlying rocks are too thick to admit of the present profitable working of the coal, leaving an area of eight square miles. We have then $8 \times 1760^2 \times 9 = 223$ millions of tons; excluding one-fourth for loss, waste, &c., as before, we will still have about 168 millions of tons of coal.

If we suppose that one-half of this quantity be of the better quality, which several of the beds of Kurhurbali field possess, and which, as determined by practical trials in various ways, extending continuously over three months, showed a superiority in the ratio of 113 : 100, this 168 millions of tons would represent a duty, or working power, equal to that of 199 millions of ordinary Raneegunge coal.

In the country between the Rajmahal Hills and Kurhurbali, there are some small outlying areas of the coal-bearing rocks, as near the village of Kuroun, &c. Coal occurs in one or two places in these, but from their very limited extent, these may be neglected in any general estimate of the amount of coal available in India.

4. Jherria Coal-Field.—This extensive, though not very rich, coal-field extends along the valley of the Damudah river, commencing about 10 miles to the west of the most westerly part of the Raneegunge field above described. Its greatest length, which is in an east and west direction, is about 21 miles, and its greatest breadth (north to south) is about 9 miles. It is traversed throughout all its length, and towards the southern limit of its area, by the Damudah river. The total area may be taken as 200 square miles.

In geological structure it is like the Raneegunge field, consisting of a series of beds divisible, as in that field, into three groups, which have a generally continuous dip from the north to the south, where they are cut off by a great fault. In one respect it differs from the Raneegunge field, namely, in the absence of any representatives of the overlying Panchet series. *Full details of the structure of this field have already been published, (a)* and it is, therefore, unnecessary to repeat them here. As regards the quantity of coal available, I have also given, in connection with that report, an approximate estimate of the amount which may roughly be calculated on from this field, amounting to 465 millions of tons.

5. Bokaro Coal-Field.—The Bokaro Coal-field commences not more than a mile to the west of the extreme western extremity of the Jherria field. From this it extends along the valley of the Damudah and of the Bokaro (one of the affluents of the Damudah). It forms a long narrow band of coal-bearing rocks of more than 40 miles from east to west, with a breadth (north to south) never exceeding 7½ miles. The total area of the field is about 220 square miles. In the centre of the field, and dividing the whole into two distinct portions, rises the massive hills of Lugoo, composed entirely of the overlying series of the Panchet Rocks, Upper and Lower. This mass of rocks covers an area of nearly 24 square miles, so that the available area of the field, so far as coal is concerned, may be taken as about 190 square miles. The field is comparatively not rich in coal, and much of what does occur is of inferior quality, and will be useful only for the ruder purposes of brick and lime-burning. For these uses, a considerable amount has been raised and carted to Hazareebagh, and even to Gya, during the past year or two. But I have been unable to obtain any return of the actual amount.

The available coal of fair quality we may consider to be represented by the seams which exceed four feet in thickness. And, in the total absence of any pit-workings which would establish the continuity or interruption of the beds, it will not be safe to take these as giving more than a thickness of four yards of coal. We would then have, say, 180 square miles by four yards of coal, giving, say, 2,230 millions of cubic yards or tons. Deducting from this total, as before, say one-third for waste and loss owing to the character of the coal, and of the deposits accompanying it, we would still have nearly 1,500 millions of tons.

Owing to the situation of this field, almost surrounded by hill ranges and broken ground, its supplies of coal cannot, under ordinary circumstances, be profitably carried to great distances. It must, therefore, be

(a). Mem., Geol. Sur. of India, Vol. V.

looked to rather as a local source of fuel than as likely to meet any general demand.

6. RAMGURH COAL-FIELD.—This small detached field occupies a triangular space along the valley of the Damudah. It extends eastwards from the old fort and town of Ramgurh, where its breadth in a north and south direction is not more than a few hundred yards, for about 12 miles. At the eastern end the field has expanded to a breadth of nearly six miles. The total area of the field is not 30 square miles. It is much cut up by faults and disturbances, presenting, however, on the whole, the same general type of structure as the other coal-fields of Bengal, a series of beds dipping generally to the south and cut off there by faults, which bring them into contact with the gneissose rocks of the vicinity. The beds of coal are not numerous, and for the most part are of inferior quality. The total available coal of this field cannot, I think, be taken as more than two or three millions of tons, if so much. Like the Bokaro field just described, this Ramgurh field also must be looked to as only useful to meet a local and limited demand : and this too, only for such coarser work as the inferior qualities of coal may be adapted to.

7. THE HOHARO OR KARUNPOORA COAL-FIELD.—The eastern extremity of this field was touched upon by Mr. Williams in 1848, but only a very small part of its area was examined by him. The field is of large extent, covering a surface of at least 450 square miles. In area, therefore, it comes next to the valuable field of Raneegunge. Close to, but detached from, this field by a narrow belt of gneissose rocks, there is another which may be conveniently called the South Karunpoora field. Its limits have not been accurately traced out as yet (the Geological Survey are now engaged in this district), but it may be taken to occupy about 120 square miles. So far as yet known, these extensive fields are very poor in coal; and what does occur is for the most part of inferior quality. They cannot, therefore, be considered likely to add materially to the chances of a good general supply of coal in India. With the imperfect knowledge we possess of these fields up to the present, it would be useless to attempt to form any estimate of the amount of coal available.

8. EETCOORA.—Near to Eetcoora or Eetkoree, to the north-west of Hazareebagh, coal occurs of poor quality, but usable for burning brick or lime. There has been much disputing as to the proprietorship of the coal, but it does not promise to be of great value.

9. PALAMOW.—Between the upper waters of the Damudah river and those of the Koel, a tributary of the Sone, a distinct ridge or water-shed is formed by the metamorphic rocks, the direction and dip of which are here materially altered. The principal fields already referred to occur along the valley of the Damudah and its tributaries. The Koel and the Sone have their distinct fields also. In Palamow some workings were for years carried on by the Bengal Coal Company near the village of Rajhera. These have been now abandoned for some years. The actual limits of this field have not yet been determined. Indeed it was only late in last year that I obtained any topographical maps of the district. A cursory and preliminary visit was paid to it at the close of last working season, and with unfavorable results. The strata appear to be a good

deal disturbed and contorted, and the district to be poor in coal. This field may, probably, be looked upon, therefore, as another of those which will principally be useful as supplying local demands. At present it certainly could not compete with other more favorably situated fields. But if the highly important project of the Sone canals be carried out, this and the other fields to the west of this, in and adjoining the valley of the Sone, will become of high value. I can give no estimate, even with the rudest approximation to accuracy, of the quantities of coal available in this Palamow field.

10. Singrowlie.—Not far to the west of the village of Singhpur, the colliery of Kotah has for years been known, and has yielded a fair amount of coal of good quality. The quantity raised has been limited by the difficulties of transport to market. No local demand exists, and the nearest point where much fuel is required is Mirzapur, a distance of more than 80 miles, with the river Sone, and the steep and difficult scarp of the Kymore Hills, intervening. Kotah itself is close to the limits of British territory. In the adjoining territory of the Rajah of Rewah, coal has not, that I am aware of, been actually worked.

The vast importance of determining even rudely whether good supplies of fuel were procurable there led to the Geological Survey undertaking a preliminary examination of the country. No very detailed investigations could be carried out, save with an expenditure of time which was not admissable, because nothing which could have any pretension to be called a map of the country was available. A few routes across the district had been plotted, and a few distant points noted. Many even of these were ridiculously inaccurate, and so far as maps were concerned, the area was practically a blank. Nothing more, therefore, than a cursory examination could be attempted. This proved the existence of coal of fair quality in many places (eight or nine different localities) extending from Kotah on the east to Beryli on the south-west, and spreading over an area of about 40 miles in length from east to west, and 20 in breadth from north to south. There is little doubt that much good fuel will be procurable from this area, but, in the absence of all details, it would be useless to attempt any estimate of the amount.

So soon as the Topographical Survey of this area, which is now in progress, be completed, the detailed examination of it will be taken up.

11. Upper Sone Fields.—A very large area, extending along the Upper Sone, the Mahanuddy, and from thence down to Sohagpoor, and the vicinity of Ummerkuntuk, has also been visited in the same cursory way, and roughly mapped. The prospects of any large amount of coal being available from this district are not good. Some thin seams, apparently unworkable, were noted in the Mahanuddy valley, near the district of Bijiragoogurh, where coal, if in quantity and of fair quality, would be most valuable. And some seams were also seen near to Sohagpoor further to the south, and near to Anoorpore.

The whole of this large area will require careful investigation, and it will be taken up the very first season that the maps are procurable.

12. Hutsoo or Chutteesgurh-fields.—It is very possible that the large area of coal-bearing rocks to which I have just alluded is geolo-

gically united with the field now to be noticed. The Hutsoo is an affluent of the important river the Mahanuddy, which flows into the Bay of Bengal, past the town and station of Cuttack; the Hutsoo, or Husdoo, rises to the north in the Sirjoojah country, and joins the Mahanuddy somewhere near Seonarain. But even the courses of the rivers are unknown in this country. Near the village of Koorba, some 50 miles from the Mahanuddy, coal was noticed in the bed of the Hutsoo, so long since as 1840, and more recently (1863), Captains Burton and Forsyth, Assistant Superintendents of Forests, visited the place. Coal occurs in the Husdoo or Hutsoo near Koorba: in the Beejah Kurra, 25 miles north-east of Koorba, and in the Labed, a few miles further on in the same direction. It is said to extend about 200 yards along the bed of the former, and about a mile in the latter. Coal was also found in the Chornai stream, a tributary of the Hutsoo.

This district will be visited during the present season by Mr. Medlicott, Deputy Superintendent of the Geological Survey, but no details are yet known.

I am unable to offer the rudest estimate of the amount of coal available (*a*).

13. Talcheer.—The coal-fields in the upper valley of the Mahanuddy naturally connect themselves with those nearer to the town of Cuttack in the lower reaches of the same river and its tributaries. Of these, that near Talcheer has been examined in detail, and reports and maps have been published (*b*).

There is but little coal in the field, and that little poor in quality and useless, excepting for the rough purposes for which such fuel is needed. The total area of the coal-bearing rocks in the field is not more than 10 square miles. And it may be almost rejected from any general estimate of the available coal in India, as from its quality it will not be used excepting most locally.

(*a*). Mem. Geol. Sur. of India, Vol. I.

(*b*). These coal-fields, in conjunction with the reported coal-fields near Chanda, on the Wurda, and also the reported coal-fields in the vicinity of Sumbhulpúr, will, in a very few years, become of far higher importance and value than they are now. The rapidly increasing trade of Bombay, the certainty that it will be the great port for all postal and passenger communication with Great Britain and Europe, and the *necessity* which this involves of establishing the most rapid and safe means of transport from Calcutta, which, whether the seat of the Supreme Government or not, must always remain the commercial centre and outlet of the enormous trade of the Gangetic valley; all these will compel (and, so far as I can see, within a very few years) the construction of a line of railway which shall pass direct, or nearly so, from Calcutta to meet the existing lines from Bombay near to Nagpúr. The general direction of such a line I have indicated on the small map accompanying this memorandum. Such a line would save on the whole distance about 450 miles, or even more, a distance which at present Indian Railway rates (20 miles per hour) would represent a saving of no less than nearly 24 hours (say even 22), or taken even at English quick rates (40 miles per hour), would be equivalent to a saving of nearly 12 hours, a saving of time in postal, and of fatigue in passenger, communication which cannot be overlooked.

For the construction of such a line, which for a large part of its course would pass through a very rich agricultural country, these coal-fields will be invaluable, while, should the coal on further examination prove of good quality, they will, after construction, afford economical means of working the traffic: being most favorably placed near the centre of a long distance, where it would be difficult to obtain fuel, and being thus able to meet demands from either side.

Coal is said to occur in places near to Sumbhulpúr, between the Hutsoo and Talcheer fields, but no details are known.

14. NERBUDDA VALLEY.—Passing now to the west, and crossing the ridge which divides the drainage basin of the Sone River from that of the Nerbudda, we come to another valuable field of coal rocks. Along the southern side of the Nerbudda Valley, these rocks appear in several places extending from the vicinity of Jubbulpur for miles down the river course. Of this district a detailed report and map has been published. It will be unnecessary to repeat here the full details already given to the public, or to give a list of all the localities where coal has been noticed. Of these many are practically useless from the thinness of the seams or other causes, and I shall, therefore, only allude in the briefest way to the more important.

A thin seam was partially opened out at Lameta Ghât near Jubbulpur, but proved useless. The locality would have given great value to any good coal found here, but there seems no ground to hope for beds of any extent in this place.

Further to the west coal has been seen near the village of Sehora in the Sher river, and a couple of miles further up the stream near Murpipria village; in the Sakur stream near Hutnapur village, and the Sitariva stream near Mopani. At the latter locality the Nerbudda Coal and Iron Company have their works. Effective preparations have been made for the raising of this coal on a large scale, and so soon as the opening out of the Great Indian Peninsula Railway to Jubbulpur renders it possible to transport the coal with economy, there is no question that a large and increasing demand for this fuel will exist; in fact, a much larger demand than it will be possible to meet from a single colliery. Hitherto, owing to the difficulties of carriage, but little coal has been sent away from the mines. These are about 10 miles from the line of railway to which a connecting line of tramway will be constructed. This Mopani coal is very much of the same general character and quality as the coals of the Raneegunge field in Bengal. So far as known, it is inferior to the *best* coal of this field and to that of Kurhurbali. A practical trial of it in 1862, the coal used being in large lumps and in good condition, showed that 220 cwts. of the coal used both in passenger and goods trains, at different times and in different locomotives with different drivers, gave about one-fifth or 20 per cent. of ash! Trials at the same time with West Hartly coal showed less than one-thirteenth or about 8 per cent., and with Brymbo coal, about one-fourteenth, or a little more than 7 per cent. The Nerbudda Company have had these mines since 1861, and the experiments referred to, although the most recent to which I have access, were, therefore, made before the mines had been carried far into the seams. And it is not improbable that the coal now being raised would yield more favorable results. Assay by Dr. Haines, Bombay, in 1860, showed 18·09 per cent. of ash in this coal.

Near to the village Lokurtullye, about 20 miles south-west from Hoshungabad, is the most westerly point at which coal or the coal-yielding rocks have been noticed. From this westwards to the coast of the Gulf of Cambay, the country has been examined in the hope that more favorably placed deposits might be discovered, more accessible from

the sea-coast and from Bombay harbour. But no trace of these formations has been met with. The coal at Lokurtullye is in seams, which, so far as known, are too thin to be workable.

The coal rocks stretch well to the southward from the Nerbudda river up the valley of the Tawa, towards Shapur and Baitool. Several outcrops have been traced in this country, and among these possibly one or two will prove workable with profit. The beds are, however, very variable in thickness, though of good quality. At Rawundeo Hill eleven or thirteen outcrops of coal are seen, and of these one or two are at least four feet thick. At all the other places noticed, Sonadi, Sooki river, near Shapur, Murdanpur, no seam was found of sufficient thickness to justify the anticipation that they will be worked.

No estimate can be formed of the amount of coal available in the Tawa valley portion of the Nerbudda district.

Pench River.—The same coal-bearing rocks stretch continuously along the southern flank of the Puchmurrie Hills to the parallel of Chindwarra, where they become finally covered up by the great flows of trap rocks which spread over the Deccan and adjoining countries. Near to Oomrait (Umret), and along the valley of the Pench river, beds of coal have been traced, which promise to be of much value. These occur (proceeding from east to west) at (1) Sirgori village. One seam cut into to the depth of 4 feet 9 inches, but bottom not reached; a second seam of 3 feet; (2) Chenda or Digawani (Pench river), a seam with more than 12 feet of coal; (3) Hurrye, thickness of seam unknown; (4) Rawunwarra, seam 7 feet, with 5 feet 4 inches of coal; a second seam, thickness unknown, more than 3 feet of coal; (5) Parassia, above 5 feet of coal; (6) Bhundaria, seam of 15 feet 2 inches, with more than 7 feet of good coal; (7) Pootaria, more than 5 feet of good coal; (8) Burkoi, about 6 feet of good coal; (9) Gogri, 6 feet seam, with 5 feet of coal. All these beds dip at angles nowhere exceeding 10°, and are for the most part favorably placed for working.

The field is 90 to 100 miles from Nagpoor, to reach which one range of ghats has to be passed over. And this distance from any present market is the greatest drawback to the profitable working of the field.

Coals in this part of the Nerbudda country have only been raised as yet from one of the seams noticed above; that at Burkoi, the first and only seam known until 1865. This colliery has been held on lease since 1860, and worked only to a limited extent from the difficulty of bringing the coal to the places where a demand for it existed.

In addition to the localities noticed above, where coal is actually known to occur, and where the formation in which it occurs has been traced, there are some others where coal has been reported, but which have not been examined by any of the Geological Survey Officers.

15. Chanda.—One of these is in the vicinity of Chanda near the boundary of the Nizam's dominions. No details are given beyond the statement that coal occurs. There is a probability that this may prove well-founded. And the discovery of good workable coal in this neighbourhood would be of so much importance and value that one of the staff

of the Survey has been deputed to visit the place this season, and also to examine the country between this and Nagpore.

16. Kota.—At or near Kota on the Godavery, still further to the south, coal has been more than once reported. The localities were examined by Mr. Wall in 1857, but without any success, and specimens obtained some years since proved to be only thin papery laminæ of a jetty substance in earthy shale. The bed is only very thin, and even if in quantity, it will be useless as a coal. On assay it was found to contain two-thirds of its weight of ash. Similar thin layers of coaly character have been stated to occur in other places in the same district; but nowhere in that direction does there appear to be a well founded prospect of the discovery of valuable deposits of coal. In the valley of the Kistna, and of the Pullair, a tributary of the Kistna, near Battavole, or Juggia-pettah, coal has been stated to occur by Major Applegath. It has not, however, been traced, and, judging from the specimens of the rocks I have seen from this district, I do not anticipate that it will be found to exist there in any quantity, if at all.

17. Cutch.—Several attempts have been made to work some thin seams of coal which occur in Cutch. The relations of these were long since described by Captain Grant *(a)*; and the place was visited a few years since by Mr. William Blanford, of the Geological Survey. The coal unfortunately offers no hopes of proving valuable as any general source of fuel. The total thickness of the seam does not exceed two feet six inches, while the *coal* in this shaly seam is only one foot four inches thick. It is, therefore, unworkable excepting close to the surface. It is useless to attempt to form any estimate of the quantity of coal existing here.

18. Sind.—For many years there had been successive reports of committees, of coal-viewers and others, regarding the existence of coal near Lynyan, north-west of Kotree, the present terminus of the Kurrachee Railway. European miners had been sent there, and at great expense pits had been sunk, and some coal extracted, when, in 1863, I deputed Mr. William Blanford, of the Geological Survey, to visit the place and ascertain the true nature of this deposit, and see if there were any probability of deposits of a similar kind occurring in the vicinity. A report on this matter submitted to the Government of Bombay was published in the *Government Gazette* at the time, which proved that no prospect existed of other beds being found, and that the deposit which had been partially worked was not a true bed, but an irregular accumulation, which did not extend a stone's throw in any direction from the pit which had been sunk.

As a source of fuel, it was therefore utterly worthless.

19. Salt-Range.—Near to Kalabagh on the Indus, and at several places along the southern face of the Salt-Range to near the Jhelum, irregular seams of lignite have been traced. These were described by Dr. William Jameson and Dr. Fleming many years since; and their comparative worthlessness as a source of fuel insisted on. But here as in

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(*a*). Trans. Geol. Soc. London, 2nd Ser., Vol. IV.

so many other instances in a new country, change of officials and a new and increased demand for fuel led to the value of these limited beds being again discussed. I personally visited, therefore, every known locality where such deposits had been traced in 1863-64, passing along the entire length of the Salt-Range, and into the districts of Bunnoo and Kohat to the west of the Indus River, and the results of this investigation were published in the early part of 1864 (*a*).

There is nowhere in that area a prospect of any large supply of this so-called coal. What is procurable is of very inferior quality, and even where it occurs under the most favorable conditions, there appeared to me only a prospect of obtaining about 40,000 tons at any reasonable rate. The coal, unless it be carefully picked, is so impure that it cannot be used in locomotives.

The Salt-Range may, therefore, in my opinion, be rejected from all calculations of the available supplies of good coal in India, excepting for immediately local demands, and for such common purposes as this inferior coal may suit.

20. Murree, &c.—Patches of coal or lignite have been found in several places along the outer range of the Himalaya mountains. In many cases these lignites have been of bright, clean jetty substance and burned well, and have thus given rise to hopes of continuous deposits of coal, which the facts did not justify. Many of the pockets of this so-called coal have been entirely extracted, and have not yielded more than half a maund (40 lbs.) of the coal. Details as to the mode of occurrence and the localities of these may be found in 'Correspondence regarding the occurrence of coal in the Punjab,' published by the Department of Public Works in 1859.

Similar nests or pockets of lignite (in the majority of cases nothing more than the fossilized stem of a tree imbedded in the sandstones in which they occur) have been observed in various places near the southern foot of the Himalaya, below Simla, Mussoori and Nynee-Tal; and to the east extending into the Nepal territories. But in all cases these have proved to be of irregular shape and size, and never of any extent. In very many instances also the amount of coal was very small indeed as compared even with the size of the nest of carbonaceous matter, inasmuch as this coal consisted only of the fossilized bark of the imbedded stem, while the mass of the block was composed of hard siliceous sandstone blackened by the presence of carbon, but entirely incombustible.

21. Darjeeling.—At the foot of the Darjeeling Hills, near the point where the Teesta river leaves the hill, and up the channel of the Sivok (*b*), a tributary of the Teesta, similar patches of lignite have been found, and have given rise, on more occasions than one, to the hope of an important coal-field existing there. They have, however, all proved to be similar to the others already noticed, namely, either detached fossilized stems of trees, imbedded in the sandstones, or nests of lignite of no extent.

(*a*). Memo. on results of examination of Salt-Range in Punjab, and of parts of Bunnoo and Kohat, &c., &c., Calcutta, April 1864.

(*b*). Journal Asiatic Society, Bengal, 1854, Vol. XXIII, p. 201.

There are, however, evidences of the coal-bearing rocks occurring near to Punkabaree at the foot of the Darjeeling Hills; but their limits have not been traced, and no coal is as yet known to occur there.

22. ASSAM.—Regarding the coal of Assam, we have little detailed information. The extreme difficulty of moving about in these districts, the utter absence of roads, and the neglected and almost depopulated state of the country, have all tended to prevent the opening up of the mineral deposits of the province. More recently the largely extended cultivation of tea, and the consequently increased demand for means of transport and communication, have directed attention to the local supplies of fuel for the river steamers which now navigate the Brahmapootra, and for other purposes, for which this coal must be brought rapidly into use.

In 1864-65 Mr. H. B. Medlicott, Deputy Superintendent of the *Geological* Survey, visited this province and reported most favorably of the value and extent of the coal. To the north of the River Brahmapootra no coal worth working was found. To the south, in Upper Assam, the principal localities are in the neighbourhood of Jaipur or Jeypore, in the Dibrooghur district, and in the vicinity of Makoom. The chief places are the Terap, where a minimum thickness of five feet of bright clean coal, nearly horizontal, was seen; Namchik, a tributary of the Deehing, where within 200 feet in length, three thick beds of good sound coal were seen, one 8 feet thick; and Jaipur, where a seam of 17 feet thick occurs, of which 10 feet is good bright coal. Several other seams also exist which have never been touched. In many other places also indications of good coal occur. The inaccessible nature of the country, however, and the want of anything like a trustworthy map, render it quite impracticable at the present to obtain even an approximate idea of the extent of area over which these beds range, and, therefore, of the amount of fuel available.

It can, however, be unhesitatingly asserted that this amount is very large and most valuable.

Assays of the Assam coals showed a proportion of ash not exceeding 2 to 5 per cent. (*a*)

23. KHASI HILLS.—The occurrence of good coal in the Khasi or Khasia Hills, lying to the north of Sylhet, and between the valley of Assam on the north and the plains of Sylhet and Cachar on the south, was known so long since as 1815, when specimens of it, forwarded by Mr. Stark (*b*), were practically tested at the Government Gun Foundry at Cossipore, near Calcutta, and were very favorably reported on. Subsequent years saw several spasmodic efforts to work these beds, but the great practical difficulty of bringing the coal to market rendered all these abortive. This difficulty arises from the fact that the coal beds occur at an elevation of nearly 4,000 feet above the adjoining plains, from which the hills rise with a nearly vertical scarp. This has prevented the construction of any mechanical means of transport, with any moderate

(*a*). Memoirs Geological Survey of India, Vol. V., p. 405.

(*b*). Ibid., Vol. I, p. 185.

outlay. And the only available means of conveying the coal from the mines down to water carriage below has been and is still by actual porterage on men's backs. It is scarcely needful to point out that this is too costly a means of transport for an article like coal, while the small number of porters available, even at such costly rates, renders the amount which *can* be brought down extremely limited.

The coal is of excellent quality, and is specially well adapted for making gas. It is also admirably suited for steamers, locomotives, &c. On the whole, it is remarkably free from iron pyrites (sulphur), and if procurable in large quantities at a fair rate would be a most valuable fuel.

A detailed description of these coals, and of their mode of occurrence, was published in 1854, and reprinted in 1857 in the first Volume of The Memoirs of the Geological Survey of India. This description was necessarily confined to such parts of the district as could be visited during the monsoon, the only period of the year in which it had been practicable to visit the locality. Since then any more detailed examination of these hills has been deferred until the party of the Topographical Survey, which has lately proceeded there, shall have prepared plans of the area. It is hoped that a few years will now place us in possession of carefully surveyed plans.

Within the last few years this coal-field has become practically of greater importance than previously. Communication by river-steamers with Sylhet and Cachar has been opened up in connection with the Eastern Bengal Railway, and this Cherra coal is now beginning to be looked to as a likely source of supply both for steamers and rail. This important change was fully anticipated by myself, and in reporting on the district in 1854, twelve years since, I said *(a)* :—"I fully anticipate, however, that the coal of Cherra Poonjee, and of this frontier generally, even though it be not possible to bring it with profit to the Calcutta market, will turn to great and useful account at some future and not very distant period. I cannot anticipate that the extensive districts of Sylhet, Cachar, and Munipur, with the prospect of an increasing traffic from the East along this valley, can be much longer deprived of the benefit of steam communication. The noble river Soorma stretches in one continuous course throughout the entire distance. * * * *

This unbroken line of water communication, stretching for more than 350 miles from Calcutta, seems specially adapted for such an enterprise, and if once a steam communication be opened along this river, the coals of the frontier will prove highly valuable for the supply of the requisite fuel at an economical rate," &c., &c.

The quantity of coal available in the Khasi Hills cannot easily be stated. I estimated in 1853 that the quantity remaining in the immediate neighbourhood of Cherra Poonjee did not exceed 500,000 tons. To this must be added the coals which are found at many other points to the east of Cherra. I estimated that the amount at or near Lakadong, in the Jynteah Hills, was about 1,500,000 tons *(b)*. And, if to these

(a). Memoirs Geological Survey of India, Vol. I, p. 200.

(b). Ibid., Vol. I, p. 194.

known localities we add others, the probability of the existence of which to the west of the parallel of Cherra Poonjee (and in all likelihood, too, at a lower level in that direction) I indicated in my report, there can be little doubt that we may safely take the available coal of the Khasi Hills as amounting to more than 3,000,000 tons. It is not improbable that double this quantity will prove to be nearer to the true amount.

24. GARO HILLS.—At the most westerly extremity of the same range of hills, where the country of the Garos or Garrows overhangs the Brahmapootra, just below its great curve to the south, coal was stated to occur in more places than one. The situation is one of the very highest importance. The general character of the rocks is known to be similar, and of the same general geological age as those occurring more to the east. There was, therefore, every likelihood that it was quite true that coal did extend to this western end of the hill range. I have on more occasions than one endeavored to obtain further information regarding these localities, but unsuccessfully, so far as the occurrence of any coal is concerned. Very recently, Mr. Dodgson, who has charge of a factory in the vicinity, and to whom I am indebted for the information, visited all the localities where coal was said to occur (Coal Committee's Report 1845, p. 121), and he brought away with him specimens of all the rocks he noticed. He failed to find any coal. A very curious and interesting bed of shale, so highly charged with a resinous amber in disseminated globules that it burns freely and with much flame, was found at one of these places. But this was the nearest approach to coal. So soon as good maps of the adjoining country are available, this area will be visited. It is exceedingly jungly, and very inaccessible.

CACHAR.—Statements of the occurrence of coal in Cachar in several places have been made on many occasions. Several specimens have been brought to me at various times for analysis. In all cases these were in small fragments, and with precisely the structure and character so markedly present in those instances of fossilized stems to which I have alluded above. Like the coal from many other of these nests or pockets, much of it was bright and jetty, and would yield fair enough results on assay. But such little pockets of even good coal are useless as a source of fuel on any workable scale. I have not heard of any case of true beds of coal in Cachar. The geology of the country is almost unknown, as is also to a large extent the topography.

25. CHITTAGONG.—Similar specimens have been sent to me from Chittagong. As no examination of these countries geologically has yet been made, I cannot venture to assert that coal does not occur there. But can assert that nothing in any one of the many specimens I have seen at different times and from different places would lead me to infer that any regular or continuous deposit of coal will be found.

CHEDUBA, SANDOWAY, &c.—The coal said to occur in the Island of Cheduba, and near Sandoway, appears to have been of the same general character as that just noticed, and to have been simply little nests of fossilized wood. A specimen recently sent up here for analysis yielded no less than 48·7 per cent. of ash.

26. BURMAH.—In British Burmah no workable coal is known to occur. A nest of coal or coaly matter, precisely similar in its general condition to the nests I have already noticed, was found some years since (1855) near Thayet Myo, and great expectations were formed of its proving very valuable. A limited excavation, however, proved how very small was the amount, and the whole was exhausted before more than a few hundred weights of coal were obtained (*a*).

In Upper Burmah (Burmese territory) some irregular beds of inferior coal (lignite) were examined by me, when I visited Umerapoora along with Colonel Phayre, envoy from the British Government to the Court of Burmah (*b*). They hold out no prospect of supplying any thing more than a very local and limited demand, and even this with inferior fuel.

27. TENASSERIM PROVINCES.—Beds of coal near Mergui in the Tenasserim Provinces were examined by me in 1854 (*c*.) They also hold out little prospect of affording a large supply, while the coal is of inferior quality. It is interesting as containing masses and globules of a resinous amber, very like that already noticed as occurring in the shales at the western foot of the Garrow Hills. The imbedding rock has here, however, been much more highly mineralized, and forms a usable 'coal.'

In the preceding very brief summary of the localities where coal is known to occur within the limits of British India, I have purposely endeavoured to be as concise as was possible. And I have, therefore, intentionally avoided all reference to details of structure of the coal-fields mentioned, and all questions of a scientific nature, directing my attention solely to the position, area, and value of each of the districts noticed as coal-producing localities.

For all details of geological structure, so far as these are known, I would refer to the Memoirs of the Geological Survey of India, and to the other notices which have been incidentally quoted above.

On the small map which accompanies this memorandum, no attempt has been made to exhibit any details of geological structure; indeed the scale of the map is such as to preclude this being done with any effect. It has been simply my object to indicate generally, as I have already stated, such portions of the British Empire in India regarding the structure of which there is sufficient knowledge to justify the assertion that there is no prospect of coal being found, or if it do occur, that it will be found at such depths as would preclude the economical working of such beds. Then, further, as regards those parts of the country in which coal is known to occur, when sufficient detail has been obtained, I have shown the actual position, outline, and extent of the coal-fields, and when the

(*a*) Selections from Records of Government of India, No. X., pp. 67, &c.

(*b*). Geology of Irrawaddy, Calcutta, also published as Appendix to Yule's Mission to Ava: Lond., 1858, p. 309.

(*c*). Selections from Records of Government of India, No. X.

fact of the occurrence of coal is all that is known, this is indicated without showing any definite limits, or boundary; while those districts of which the geological structure is unknown are left uncolored.*

II. Quality of Indian Coals.—In forming an estimate of the value of coal, and of the proportional quantities which various countries are likely to yield, a very essential consideration is the quality of the coals, as determining their 'duty' or amount of work done by similar quantities. At first, of course, before coals are worked to a sufficient extent to admit of this 'duty' being tested by long continued series of practical experiments, the only means of arriving at a satisfactory knowledge is by direct analysis or assay of the mineral. This plan is, however, always subject to error. The portion experimented upon is necessarily small, and it is scarcely possible to obtain in such small specimens a thoroughly fair representative of the general quality of a bed. And further this quality will itself vary, and vary materially, in different parts of the same layer. Still taking care to select not picked, but fair average specimens, and combining several of these, it is possible to obtain truly comparable results by assay. In 1862 I had the opportunity of sending to the International Exhibition in London a very fine series of specimens of the principal beds of coal at that time worked in India, and I accompanied these by assays of the same coals. These were chiefly from three fields, Kurhurbali, Ranigunj, and the Rajmehal Hills. Many other assays have at various times been made in the Geological Survey Office, and I append a list of the majority of these, in which the relative amounts of fixed carbon, of volatile matter, and of ash, are given for 80 different varieties of Indian coals.

Composition of Coal from Indian Coal-fields.

No.	Localities.	Fixed carbon.	Volatile matter.	Ash.	Remarks.
	Kurhurbali Field.				
1	Mollichooan	64·9	24·8	10·3	
2	Ditto	68·6	24·8	6·6	
3	Ditto	73·1	22·1	4·8	
4	Passarabhaya	68·5	19·0	12·5	
5	Boreeadeh	66·3	23·0	10·7	
6	Choonjhoonkee	67·2	24·0	8·8	
7	Jutkutti	50·9	15·1	34·0	
8	Ditto	48·2	12·6	39·2	
9	Khandia Hill	57·1	16·4	26·5	

* To prevent any misconception, I would state, that I have treated as 'coal' in the above remarks, any deposit which can be used for the purposes for which coal is ordinarily employed, without reference to its geological age. As regards the latter point, I may add, that Nos. 1 to 14 (in the list given above) are all of the geological age of the coal bearing rocks of India (the *Damuda* series of my classification), which probably corresponds to the uppermost parts of the Palæozoic times of European and American Geologists—The age of No. 15 (Chanda) is most probably the same, but is not yet determined,—that of No. 16, (Kota) is most probably Liassic;—that of No. 17, (Cutch), probably Lower Jurassic, certainly not older; while the remaining numbers in the list, Nos. 18 to 27, are all Tertiary.

Composition of Coal from Indian Coal-fields,—continued.

No.	Localities.	Fixed carbon.	Volatile matter.	Ash.	Remarks.
	Rajmahal Hills.				
10	Mussinia	57·60	34·40	8·00	No caking.
11	Ditto	48·80	30·40	20·80	Gaseous.
12	Panchbyni	44·2	34·1	21·70	
13	Goomoo	36·00	45·60	18·40	
14	Chilgo	45·50	43·5	11·00	
15	Oormoo	45·00	44·6	10·40	
16	Ditto	45·30	35·5	19·20	
17	Ditto (picked)	57·30	41·2	1·50	
18	Bankijora	43·50	42·0	14·50	
19	Teesaphoolie	48·80	37·20	14·00	
20	Ghutkum	43·20	44·40	12·40	
21	Lohundia	45·20	44·80	10·00	
22	Bhora	25·20	37·20	37·60	
23	Dangaparah	35·40	45·40	19·20	
24	Ghatchoura	41·60	28·80	29·60	
	Ranigunj Field.				
25	Ranigunj	50·8	36·0	13·2	
26	Ditto	50·3	36·3	13·4	
27	Searsole	51·1	38·5	10·4	
28	Ditto	57·25	41·00	1·75	Selected, rich layers only.
29	Nimcha	47·00	31·50	21·50	
30	Bansra	47·00	40·00	13·00	
31	Mungulpur	43·9	38·4	17·7	
32	Ditto	44·75	37·00	18·25	
33	Babusole	46·0	35·4	18·6	
34	Madabpur (Harispur) ...	51·1	35·4	13·5	
35	Parasia	44·00	32·00	24·00	
36	Topossi	49·20	35·40	15·40	
37	Ditto	53·75	31·50	14·75	
38	Chokidanga	56·50	35·00	8.50	
39	Ditto	56·80	34·00	9·20	
40	Dhosul	55·26	34·00	10·74	
41	Jot Janki	48·50	30·50	21·00	
42	Gopinathpur	53·25	35·25	11·50	
43	Bonbahal	48·4	38·7	12·9	
44	Kasta	61·40	28·00	10·60	
45	Ditto	43·50	32·80	23·70	
46	Jemeri	55·60	84·00	10·40	
47	Futtypur	63·80	25·00	11·20	
48	Mainanaggur	54·35	35·52	10·13	
49	Rogonath-Chuck	50·50	36·00	13·50	
50	Ditto	46·90	35·00	18·10	
51	Banali	42·60	44·20	13·20	
52	Bhangaband	40·30	28·40	31·30	
53	Chinakuri	53·20	35·50	11·30	
54	Hatinal	61·00	27·50	11·50	
55	Mahuldabar	39·20	25·60	35·20	
	Jherria Coal-field.				
56	Lodona	63·0	26·0	11·0	
57		53·8	18·	28·2	
58		66·	21·5	12·5	Sent by Major Sherwill, the exact locality not being stated.
59		68·4	20·5	11·1	
60		65·8	14·	20·2	

Composition of Coal from Indian Coal-fields,—continued.

No.	Localities.	Fixed carbon.	Volatile matter.	Ash.	Remarks.
	Assam.				
61	(?) ...	56·94	41·1	1·86	Dr. Bourne.
62	Namber River	30·80	40·40	28·80	Mr. Masters.
63	(?) ...	39·8	35·2	25·0	Mr. Masters; exact locality unknown.
64	Terap	61·8	36·5	1·7	Mr. Medlicott.
65	Namchik	50·4	44·6	5·0	
66	Jeypur	53·0	43·3	3·7	
67	Raipoor	66·	31·2	2·8	
	Central India. *Pench River.*				
68	Senda	61·	16·	23·	
69	Burkoi	30·3	26·	23·7	
70	Bootaria	49·3	26·5	24·2	
71	Sirgori	61·6	28·	10·4	
72	Sonadi	54·4	29·6	16·	
73	Burkoi	57·27	24·00	18·73	Assay by Dr. Haines.
74	Mopani (Nerbudda) ...	48·54	33·37	18·09	Ditto ditto.
75	Nepal	50·8	47·	2·2	
76	Ditto	34·08	54·02	11·9	
77	Salt Range	46·9	48·	5·1	9·2 water.
78	Chittagong	37·15	46·50	16·35	Sulphureous.
79	Sandoway	37 3	14·	48·7	
	Madras.				
80	Godavery River	23·3	20·5	56·2	C. Æ. Oldham. Paper coal.
81	Ditto	23·0	17·6	59·4	Sir B. Frere. Paper coal.
	English Coal saleable at Calcutta.				
	1	70·3	27·5	2·2	
	2	63·8	34·2	2·0	
	3	74·6	22·6	2·8	
	4	65·8	30·8	3·4	
	5	66·0	31·0	3·0	

Rejecting from this number, for our present purposes, all those which are from localities where no *workable* amount of coal can be looked for, and taking in this way the first 74 on the list, we find that the *average* composition, as determined from this number of Indian coals, would be fixed-carbon, 52·2, volatile matter, 31·9, ash, 15·5.

Again, I have given similar results of assay of five specimens of English coals, such as were saleable in the Calcutta market during the last three years. The exact locality from which these coals were shipped is unknown, but they were good quality English coals for public sale. The average composition of these was fixed carbon, 68·10, volatile matter, 29·20, ash, 2·70.

Now, the relative duty or effective power of coals may be taken to vary directly as the amount of fixed carbon which they contain; and taking this test we perceive that out of the whole series of Indian coals,

only one or two come up to this average, or, in other words, that the *very best coal of Indian fields only touches the average of English coals.* If, on the other hand, we take the relative amount of ash, matter which does not contribute to the heating power of the coals, we find that the average of Indian coals shows no less than 15½ per cent. as against less than 2¾ per cent. in English coals.

These figures show how very seriously inferior to ordinary English are the Indian coals. Analysis thus fully confirms the general idea. Practical trials on the large scale show the same result. The two most heavily worked lines of Railway in India, namely, the East Indian (Bengal), and the Great Indian Peninsula (Bombay), use, respectively, Indian and English coal. And their relative consumption is 150 tons per mile in the former, as compared with 75 tons in the latter.

It is therefore certain that Indian coals are not capable of more than two-thirds, in most cases not more than one-half, the duty of English coals.

This becomes a most important element in attempting to form any estimate of available quantity. I have already alluded to this (Mem. Geological Survey India, Vol. V., page 334). "In attempting to estimate the value of any field, it must be remembered that this depends not so much on the actual amount of coal which it may contain, as on the way in which that coal is accumulated, or the conditions under which the beds occur. Six seams, for example, of one foot thick each, would contain twice as much coal as one seam of three feet supposed to cover the same area. The latter, however, or the three feet seam might probably be worked with profit, while it certainly would not pay to work seams of only one foot thick; I should perhaps more correctly say to *mine* seams of one foot thick. If such seams were accessible in open cuttings or quarries, they might be profitably extracted. But further, the question of what seams can be worked with advantage will depend for its solution on the dip or angle of inclination of the beds; on the vicinity and extent of the demand or market; and on the skill of the labour at command. And if the ruder labor which can be obtained in this country, as well as the absence of all those mechanical appliances which exist so abundantly in the long established collieries of England and other countries, be taken into consideration, I think I am quite within the truth in asserting that no seam of coal can be mined in this country with any fair prospect of profit which is not at the least four feet in thickness.

"I am aware that seams of even less thickness than two feet, the half of this, are worked in England; but these are not common cases. And it certainly would not be justifiable to take the experience of a highly civilized country like England, where everything is in favor of such operations, as a guide in estimating the practicability of working seams of coal in this country: there a local demand would be found to exist in almost all places; there is a large, widely-spread, and skilled mining population, and great facilities for securing and raising the coal. And in addition to all these points, there is the superior quality of the coal itself. It must be admitted that on the average Indian coals are not equal in value to average English coals. In few cases are they worth

more than two-thirds of English coal, in some cases not more than one-half. In this way a seam of Indian coal of three feet thickness would only be the equivalent of one of 18 inches, or of two feet, of English coal."

But the relative amount of ash, which is useless matter, will also most materially affect the cost of carriage. If that amount be on the average 15·5 per cent., it is obvious that in every ton of coal carried, more than one-sixth of useless material is also carried. And this becomes a very important element when space or stowage is concerned.

This inferiority of the Indian coals has prevented their being much used, therefore, in any cases where the fuel is not to a large extent locally attainable. Very few sea-going steamers, for example, will burn 'country coal.' Messrs. Mackinnon Mackenzie and Co., Calcutta, the Agents of the British India Steam Navigation Company, the largest and most successfully managed Company trading with steam-ships all round the coasts of India and adjoining countries, have very kindly given me the benefits of their valuable practical knowledge on these questions. They state that their experience of Indian coal has been very limited so far as sea-going steamers are concerned, as they had not found it suit their requirements well for the following reasons:—"*1st.* Speaking generally and without having gone into experiments to ascertain exactly the properties of Indian coal, we find that to produce a given heat, about one-half more is required of Indian than of good English coal. *2nd.* We do not find it to have so injurious an effect on the heating surface as English coal, as it forms a slag, and protects the iron from the effects of the heat; and, again, it is open to an objection in this respect, as the slag blocks up the furnace-bars, and prevents ventilation. *3rd.* The ash and clinker turned out being, roughly speaking, about 50 per cent. greater than results from the use of English coal, the staff of firemen and coal trimmers is increased in a corresponding ratio. *4th.* Rubble coal being alone used for steamers, it occupies much more space in the bunkers. Small coal will scarcely burn, being so earthy and impure."

They add—"We do not find English and country coal to burn well together, although, for economical reasons, we occasionally mix them. The country coal requires the furnaces to be so frequently cleaned that the unconsumed English fuel is drawn out before it is fully exhausted."

These experiences appear conclusive against the use of Indian coal for sea-going steamers, at least so long as better fuel can be had.

The prevalent opinion, that there is very great danger from the use of Indian coals, owing to the tendency which most of these coals show, under peculiar circumstances, to self-ignition, is, I think, exaggerated. While, under the old system, the coals from the Raneegunj coal-field, about 130 miles from Calcutta, were often more than two years before they reached their market, and during this time had been exposed to the great changes of temperature as well as to the great moisture of a tropical plain, such accidents were undoubtedly likely to occur. But more recently when the coal often reaches Calcutta and is shipped in less than 24 hours from the time it was hewn in the pit, the coal is much safer to use. On this point, of the tendency to self-ignition, Messrs. Mackinnon and Mackenize say—"The general opinion appears to be that it is more liable to self-ignition than English coal, but we have never found it so in the

steamers. We have only shipped two cargoes by sailing vessels; one on a short voyage undeserving notice, the other was shipped during the rainy season, and consequently wet, for Muscat, a seven weeks' voyage; and ship and cargo arrived safely."

These considerations of the quality of Indian coals will, I think, suffice to show the groundless nature of the hopes which have been expressed, that the coal-fields of " India, Borneo, and Australia and New Zealand will not alone yield ample supplies, but will also serve to coal the ocean steamers trading and likely to trade between Europe and those far distant regions" (*a*). How far Borneo (*b*) and Australia may serve to this end, I am unable to say, but Indian coal will, I fear, never supplant the better fuel now obtainable elsewhere for ocean voyages.

III.—Production of Coal in India.—In 1861 I published in the Memoirs of the Geological Survey of India ("Mineral Statistics, I. Coal") detailed returns of the out-turn of coal from all parts of India so far as I could procure any trustworthy statements for the years 1858-59 and 1860. This was the first attempt at any systematic return of the kind. We had then just completed the Geological examination of the Raneegunj field, and had taken advantage of this opportunity to obtain information. It was hoped that a similar systematic return would be compiled for successive years. But this could only be done by devoting time to this special purpose, which was urgently required in other ways. More recently, on the receipt of the despatch from the Right Hon'ble the Secretary of State, calling for the return now submitted, I again urged the impossibility of procuring the needful information, except by personal application and by personal visit to the fields, and I endeavoured also to show that similar statistical returns of the production of other minerals were also much needed. Such mineral statistics have now been for years carefully compiled by a special officer in connection with the Geological Survey of Great Britain, and indeed if this branch of the Survey had not existed, public attention would never have been so vividly aroused to the rapid exhaustion of the coal of Great Britain. Until the truth be known as to the amount of out-turn, both actual and possible, of the several mineral products of this country, and of the relative increase or decrease of this out-turn in successive years, it is idle to seek for the causes of such extension or diminution of the trade, which may exist only in fancy, and idle to speculate on the effect of opening up new markets or restricting supplies to those already existing.

In the absence, however, of any such system of statistical enquiry, I have endeavoured, by applying to each of the *proprietors* in the several fields, to procure the needed information. To some I am indebted for prompt and full replies most cordially given; others have promised the returns, but they have not as yet been received, while from several I had no reply. The latter being chiefly limited to the smaller workings are not of such essential importance.

I have endeavoured to obtain returns for the years intervening between 1860, the date of the latest return as yet published, and the present

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(*a*). Quarterly Journal of Science, October 1866, p. 477.

(*b*). The Labuan, or Borneo, coal has always been very favorably reported on. The uncertainty of the supply has hitherto prevented its being as much used as its good quality would justify.

year 1866, or for six years, which, taken with the three years previously given, will afford a sufficiently long period to trace the general progress of the trade in coal with some confidence, that temporary derangements do not affect the general result.

Seeing that these returns are very incomplete, some of the largest collieries not having as yet furnished reports of the amount raised, I am compelled to abandon, at the last moment, my intention of discussing the important question of the rapid increase in consumption, and the probable ratio, and probable limits, of that increase. The distribution also of this coal and the manner in which this is effected, are important points. The three railways alone, which have termini at Calcutta, now consume more than 200,000 tons of coal in the year, more than the total quantity raised in all India ten years since.

And every year sees a considerable extension of the lines, and increase of the traffic.

But any profitable discussion of these important points can only be attempted, when returns approximately accurate can be obtained of the total annual out-turn.

Subsequently to the first issue of the preceding report, other returns were received, which have been embodied in the tabular statement now printed. These have enabled a more complete view of the total out-turn of coal in India to be given. And I am disposed to think that we can now arrive at tolerably trustworthy results as to the comparative condition of the trade in coal, so far as Bengal is concerned, for the last eight years at least.

So far as known, the total actual out-turns of coal in India during these years have been nearly as follows, the quantity being given in Indian maunds.

In	1858	61,62,319	1863	95,12,174
	1859	99,61,928	1864	90,46,147
	1860	1,00,88,113	1865	88,37,953
	1861	78,06,252	1866	1,08,34,551
	1862	86,43,843		

For all the years after 1861, these figures are below the truth.

To get at a fairly comparative result we should reject from the returns for the three first years those few small collieries, which are still yielding coal but of which we have not been able to obtain any returns for the ensuing years, and take only those from which these returns are continuous or nearly so. This may, I think, safely be done, inasmuch as since 1860 there have been other small collieries opened, and some of the old quarries have been continued, so that it may justly be concluded that the out-turn from these minor workings have, throughout the whole time, borne about the same continuous ratio to that from the larger workings, rising and sinking with it as it did in the former years. This will, for purposes of comparison, reduce slightly the amounts, as given for 1858-59-60.

But further, if we attempt to obtain from such a statement a fair insight into the fluctuations of the demand and supply of coal, we must also take, in conjunction with the local out-turn, the amount of coal or

fuel imported. Let us for the present take only such amount of coal as has been raised in Bengal alone, and that which has been imported (including patent fuel under the head of the coal) into the port of Calcutta alone; we will have the following quantities for the last eight years:—

	Raised in Bengal.	Imported.	Total.
1859	99,61,928	12,29,160	1,11,91,088
1860	1,00,88,113	4,96,585	1,05,84,698
1861	77,85,085	12,85,203	90,70,288
1862	86,30,843	6,76,687	93,07,530
1863	95,04,975	10,36,407	1,05,41,382
1864	90,32,405	18,18,132	1,08,50,537
1865	88,10,425	16,16,143	1,04,26,568
1866	1,07,90,035	9,14,427	1,17,04,462
Maunds	7,46,03,809	90,72,744	8,36,76,553
or in Tons	27,37,754	3,32,944	30,70,699

Making a total consumption supplied for Bengal alone of more than three millions of tons, of which 332,944 tons, or about one-ninth of the whole, were imported.

Looking down these columns it will be seen that there have been curious fluctuations in the amount required to meet the demand, nor do these appear to follow any ordinary law of increase or decrease. We do not find that the amount imported varies inversely as the local supply, so that the amount thus imported would seem to depend on other considerations, than any question of demand, or as tending to make up for a deficient supply. From the facts stated in preceding pages, as to the average quality of Indian coals, there will always be a certain and considerable demand for coal of a superior quality for purposes requiring a better class of fuel. But beyond this, it is obvious that the amount of coal imported into Calcutta depends much more on questions of freight, dead-weight, and of general trade, than on any mere question of the demand for, and supply of, fuel at that place.

The local demand again, from the very fact of its being local, must vary materially from year to year. For instance during the earlier three or four of those years for which returns are here given, there was a large, but very local, demand for coal even of inferior quality, for the works of construction on the East Indian line of railway which almost entirely ceased in 1860. In that year more than an eighth part of the entire out-turn of Indian coal was raised for such purposes *alone* independently of other supplies, and a reference to the figures will show that in the following year the out-turn diminished by nearly one-fourth of the whole amount it had previously attained.

Subsequently, although the demand for works of construction diminished, the line of railway itself was gradually opened up, and the extension of communication led to greater demands for fuel. These demands have continued to increase at a rapid rate, until last year, 1866, in consequence of the extension of the use of coal instead of wood to the upper section of the line (the opening of the Jumna bridge at Allahabad enabling this to be carried out) nearly doubled the demands of the previous year. The amounts supplied for the use of the locomotive department alone on the East Indian Railway independently altogether of coal used for other purposes have been during these years as follows:—

1861	9,91,215	1864	26,96,442
1862	12,29,709	1865	28,27,953
1863	18,37,717	1866	50,79,612

We have taken the East Indian Railway* here as being by far the largest single consumer of Indian coal. But similar results precisely would follow from a consideration of the consumption on other lines of railway also.

If we exclude the consideration of this special increase in consumption, we will arrive at a fairer view of the general trade in coal, and we will find as shown below that the amount of coal raised in Bengal (independently of what was required for railway use alone) greatly diminished last year, and that the trade in coal as well as in every thing else felt all the depressing influences which so largely curtailed the general commerce of the country.

	Amount of coal raised in Bengal.		Amount of coal used on East Indian Railway.	Balance.
1861	78,06,252	less	9,91,215	68,15,037
1862	86,43,843		12,29,709	73,14,134
1863	95,12,174		18,37,717	76,74,457
1864	90,46,147		26,96,442	63,49,705
1865	88,37,953		28,27,953	60,10,000
1866	1,08,34,551		50,79,612	57,54,939

Independently of the enormous development of this one source of demand for railway consumption alone, it will be seen further that the amount raised in Bengal has steadily decreased for the last four years.

I should greatly have wished to trace out more fully the distribution of the coal used in this country and to have arrived at more satisfactory details as to the relative consumption of 'country' and English or other coals for certain purposes; but considering that our information regarding the fundamental facts of how much has been raised in this country is still defective, the above statements may be sufficient to show in a general way.

That during the last eight years there has been an aggregate consumption of coal supplied for Bengal alone, and the port of Calcutta, of more than 3,000,000 tons, of which about eight-ninths were raised in India, and about one-ninth imported;

That there has on the whole been but little increase in the demand for coal during that period, while there have also been very great fluctuations in the quantities from year to year;

That these fluctuations do not appear to have followed any simple law of increase or decrease, but to have depended on various causes, *not local;*

That the demand for general purposes would appear to have been diminishing very considerably for the last four years, but

That the consumption for railway purposes alone has increased enormously, and even now amounts to more than one-half of the total quantity of coal raised in India.

I would only add that all these statements refer solely to the consumption in Bengal, and for those railways having their termini at Calcutta. The large consumption of Bombay and Madras has hitherto been almost entirely supplied by imported coal.

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* We are indebted to the kindness of Cecil Stephenson, Esq., Deputy Agent, for the figures.

List of the Collieries worked in India during the years 1858-1866,

Name of Colliery.		Method of working.	Number of Pits or Quarries worked.	Date of establishment of Colliery.	Out-turn of Coal in				
					1858.	1859.	1860.	1861.	1862.
Newcastle Co.	...	Pits ...	...	1862-63	...	...	...	...	...
Bonbahal ...	...	Shafts ...	2	1864	...	...	...	...	...
Chokidangah	...	Ditto ...	7	1834	3,30,000	4,85,000	2,64,584	2,64,571	3,69,626
Mahomedpur	...	Quarry ... Shafts ...	1 1	1857	40,000	40,000	40,000	...	...
Dhosul ...	(1)	Quarry ...	1	1834	...	14,000	...	...	...
Ditto ...	(2)	Pits ...	3	...	...	...	No certain record.		
Jotejanaki ...	(1)	Quarry ...	1	1858	...	25,000	...	...	...
Ditto ...	(2)	Dito ...	1	1858	...	30,000	...	...	...
Ditto ...	(3)	Dito ...	1	1859	...	...	10,000	...	...
Ditto ...	(4)	Pit ...	1	1866	...	...	...	...	...
Topassi ...	(1)	Shaft ...	4	1848	...	4,80,000	3,00,000	4,70 656	6,51,543
Ditto ...	(2)	Ditto ...	4	1863	...	...	...	...	...
Bansra ...	(1)	Ditto ...	2	1859	...	1,80,000	70,000	85,098	39,306
Ditto ...	(2)	Ditto ...	1	1862	...	...	...	...	69,508
Parasia ...	...	Ditto ...	2	1859-60	...	...	30,000	23,777	...
Mangalpur ...	(1)	Quarries.. Pits ...	...	1840	4,50,000	8,50,000	10,00,000	3,67,476	3,80,880
Ditto ...	(2)	Quarry ...	...	1859	...	3,600	33,000	...	16,824
Harispur (Mudub-pur) ...	...	Pits ...	5	1857	58,000	4,43,000	4,40,000	4,67,772	3,66,684
Babasól ...	...	Ditto ...	3	1858-59	...	...	84,000	1,30,311	1,81,534
Rogonathchuk	...	...	...	1840	1,00,000	1,75,000	3,00,000	82,974	2,64,270
Damulia ...	...	Quarries.	2	1774? 1824	2,23,000	3,91,000	3,55,000	3,50,000	5,00,000
Harabhanga	...	Ditto ...	1	1859	...	...	1,50,000	...	...
Ranigunj ...	...	Pits ...	...	1816	18,00,000	19,00,000	16,00,000	13,83,510	13,27,020
Ditto ...	...	Quarry ...	...	1866	...	...	...	...	...
Sirsol ...	...	Quarries.. Pits ...	2 6	1846	12,00,000	16,00,000	14,77,789	12,76,303	12,81,113
Nimcha ...	...	Pits ...	5	1859	...	...	70,000	1,78,436	3,34,330
Jemeri ...	...	Ditto ... Quarries..	4 2	1854	2,50,000	4,00,000	3,64,095	10,71,002	10,67,039
Banali ...	...	......	...	1860	...	...	30,000	57, 700	66,537
Bhagaband	...	Pits ...	4	1840?	...	60,000	2,50,000	3,18,870	3,58,656
Satgram ...	...	Quarry ... Pits ...	1 2	1859 1863	...	...	...	69,012	59,378
Ninga ...	...	Quarry ...	1	1852	2,25,000	2,10,000	76,138	...	...
Ditto ...	(2)	Shafts ...	2	1862	...	...	...	...	7,569
Puronahdih	...	Ditto ...	2	1863	...	...	...	...	...
Charnpúr ...	...	Ditto ... Quarries..	2 2	1865 1862	80,000	80,000	...	...	...
Samsundarpur	...	Pits ...	2	1856	10,000	50,000	50,000	...	...
Barabone ...	...	Quarry ...	1	1859	...	...	10,000	...	...
Puriharpur	...	Under cut ... Quarry ...	1	1858	...	1,60,000	80,500	...	37,782
Mainanaggar	...	Ditto ...	1	1848	1,10,000	90,000	1,00,000	...	...
Dhadkia ...	...	Pit ...	1	1859	...	...	1,00,000	12,618	63,098
Assensól ...	...	Under ... cut Quarry ...	1	1857	20,000	20,000	10,000	...	...
Sripúr ...	...	Ditto ...	1	1859	...	10,000	4,000	...	...
Gushik ...	(1)	Ditto ...	1	?	...	50,000	17,099	...	...
Ditto ...	(2)	Ditto ...	1	1856	20,000	10,000	...	...	...

with statistics of method of working, out-turn of Coal, &c., &c.

Maunds for the Years				Steam Engines and Horse Power.	Thickness of Coal Seam in Feet.	Thickness of Coal worked.	Remarks.
1863.	1864.	1865.	1866.				
...	2,00,000	3,00,000	1,50,000	...	...	...	No returns; the amount is solely estimated.
...	11,570	1,06,689	1,38,954	1 14-H.P. 1 8 ,, 1 6 ,, 1 4 ,, 2 12 ,, 1 20 ,,	10-12	7	
3,38,430	5,23,288	8,84,782	14,28,307		14-26	6½	Rubble in addition to above 1865—62,628; 1866—79,783.
2,208	...	...	7,020	......	...	...	Mine abandoned; roof dangerous.
...	...	...	...	......	22	All	
...	2,500	1,50,000	4,18,900	1 10-H.P. 1 8 ,,	26	8	
...	...	...	...	......	5½	All	No returns since 1860.
...	...	...	...	......	5½	All	
...	...	...	...	......	6½	All	
...	...	...	1,17,000	......	..	...	No return, amount estimated.
6,81,574	...	...	...	1 35-H.P.	24	14	Destroyed by fire, Aug. 21st, 1863.
1,02,660	5,21,416	5,25,927	2,06,154	2 12 ,,	24	14	Flooded on 1st July; one mine is drained.
...	...	...	...	......	7	6	Abandoned; coal inferior.
1,49,975	1,06,509	18,876	45,342	1 22-H.P.	8	7	Closed for 10 months in 1865-66.
...	...	...	...	......	...	...	Abandoned; coal bad.
4,40,568	5,38,410	5,77,021	6,33,954	......	25	13½	9 feet of inferior coal in roof and 2½ feet of floor, not worked on account of soft clay under it making 25 feet.
1,82,592	19,086	...	1,52,736	......	13	13	
4,07,169	4,86,129	5,78,764	6,64,373	1 20-H.P.	17	9	
2,21,231	2,40,984	1,49,723	2,15,223	1 25 ,,	17	9	
47,610	2,46,702	60,618	3,93,495	1 11 ,,	14	9	
2,40,000	1,76,568	...	...	......	16	All	
...	...	...	...	......	16	All	Not worked since 1864.
15,01,980	11,20,152	10,75,014	13,39,535	2 25-H.P.	13	All	Cut in two distinct beds. From 1866 only work 9 feet.
...	...	...	32,438	1 16 ,,	...	...	
12,95,403	12,75,331	12,80,290	12,81,202	1 8:25:14: 10:26-H.P.	12	12	Rubble included.
4,35,336	3,73,068	6,46,594	8,85,552	1 9-H. P. 1 12 ,,	20	13	A quarry opened 1865.
10,91,395	10,83,290	10,53,001	10,50,670	1 14 ,, 1 25 ,,	12	12	Rubble included.
2,39,825	54,993	83,061	1,88,311	1-25:1 12:1 10	13	8	Remainder slate and inferior coal.
3,39,192	1,14,738	...	...	1 8 ,,	7	7	Not worked since 1864.
87,369	3,32,232	3,41,030	3,57,320	1 10 ,, 1 25 ,,	10	10	
...	...	...	...	......	...	...	No returns since 1861.
8,421	69,839	71,198	15,660	1 14 ,,	...	...	Closed for six months in 1866.
2,394	1,41,717	1,59,608	1,58,398	1 35 ,,	10	8	
47,800	85,530	55,836	1,91,177	1 18 ,,	19	All	
...	...	...	...	......	13	All	No returns since 1860.
...	...	...	...	......	17	All	Ditto.
57,984	...	...	...	1 16-H. P.	9	All	Not worked since 1863, will be re-opened 1867.
...	...	...	...	......	9½	All	Quarry opened in 1862.
83,697	87,284	1,68,420	1,18,764	1 12-16 ,,	11	10	
...	...	...	...	...	8	All	
...	...	...	...	......	7	All	
...	...	...	...	......	8	All	
...	...	...	...	......	8	All	Including rubble, in 1860—18,304 maunds.

List of the Collieries worked in India during the years 1858-1866, *with*

Name of Colliery.		Method of Working.	Number of Pits or Quarries worked.	Date of establishment of Colliery.	Out-turn of Coal in				
					1858.	1859.	1860.	1861.	1862.
Beldangah ...	...	Quarry ...	1	?	...	...	25,000	...	...
Gharoee ...	...	Quarries	3	1855	60,000	60,000	50,000	...	...
Borachuk ...	...	Ditto ... Shafts ...	4 2	1855 1858	60,000	60,000	70,000	...	...
Futtipur ...	...	Ditto ...	4	1858	...	2,00,000	1,50,000	...	...
Sitarampur ...	...	Quarry ... Shafts ...	1 4	1847 1864	1,50,000	...	...	...	...
Dhamwa ...	...	Quarry ...	1	1855	...	...	20,000	...	...
Rogonathbatti	...	Quarries Shafts ...	2 2	1865 1864	...	...	...	...	...
Sanktoria ...	...	Ditto	2	1860	...	...	...	...	...
Chinakuri ...	...	Pits ...	2	1834	3,50,000	2,73,000	3,29,000	3,17,502	2,99,328
Hatinál ...	...	Ditto	3	1857	75,000	75,000	2,00,000	1,85,137	2,13,290
Lalbazar ...	...	Ditto	2	1857	75,000	75,000	......	......	......
Chanch ...	...	Under cut Quarry	1	1830	1,41,000	2,60,000			
Nuchibad ...	...	Ditto	1	1830	......				
Dumarkunda	...	Ditto Pit	1 1	1858	......	......	2,80,000	2,31,099	2,36,222
Deoli ...	..	Under cut Quarry	1	1859	......	......	......	......	...
Kasta ..	(1)	Under cut Quarries	3	1855	90,000	60,000	38,892	......	......
Ditto ...	(2)	......	1	1849	.....	80,000	80,000	80,278	74,844
Hurrinsingah	...	Qarries	2	1854-55	48,000	......	......	......	......
Domunpur ...	...	Under cut Ditto	2	1860	......	......	2,343	......	......
Sursabad ...	...	Ditto	3	1859	......	......	75,517	......	......
Panchbyné ...	...	Ditto	1	1857	36,000	60,000	14,000	......	......
Ghatchowra	...	Quarry	1	1858	8,000	......	.....	......	......
Domunpur ...	...	Ditto	1	1859	......	30,000	8,000	......	......
Gopikandur...	...	Ditto	1	1856	7,000	......	......	......	......
Oormoo ...	...	Ditto	2	1858	......	26,000	30,000		
Koondapahar	...	Ditto	1	1858	5,000	10,000	1,000		
Chilgo ...	...	Ditto	1	1858	5,000	10,000	20,000	63,935	44,329
Bankijora ...	...	Under cut Ditto	1	1858	10,000	45,000	30,000		
Burgo ...	...	Quarry	1	1859	......	6,000	......	......	......
Teesaphuli ...	...	Under cut Ditto	2	1856	1,00,000	1,50,000	2,10,000	......	......
Ghutkum ...	...	Pit	1	1859	......	......	50,000	......	......
Simlón ...	...	Quarry	1	1860	......	......	8,000	......	......
Lohundia ...	...	Drift	1	1859	......	......	86,000	......	......
Hurrah ...	...	Under cut Quarries	2	1857	.....	4,20,000	7,00,000	......	......
Borah ...	...	Ditto	1	1858				......	......

statistics of method of working, out-turn of Coal, &c., &c.,—(continued.)

Maunds for the Years				Steam Engines and Horse Power.	Thickness of Coal Seam in Feet.	Thickness of Coal worked.	Remarks.
1863.	1864.	1865.	1866.				
...	...	...	...	......	9	All	Not worked.
...	27,150	...	...	......	...	...	Discontinued; coal inferior.
1,33,113	1,35,499	...	...	1 18-H. P.	8	All	Discontinued in 1864; coal inferior.
1,54,986	2,17,968	31,767	...	1 18 „	...	All	Discontinued.
...	...	57,112	78,490	1 18 „	12	All	
...	...	...	...	......	12	All	
...	...	5,418	1,20,710	1 15 „	8	All	
72,450	1,70,654	1,63,468	1,11,338	2 9 „	10	All	
3,28,842	2,21,562	1,95,438	2,89,012	1 20 „ 1 8 „	10½	7	
2,98,748	2,27,910	70,770	......	1 12 H. P.	12½	10	
......	......	......	......	......	18½	10	
				......	10	All	
4,96,937	2,20,326	......	......	...... 1 10-H. P.	10	All	
				1 12 „	10	All	Not worked since 1864.
......	......	......	......	......	4½	All	
......	......	......	......	......	33	11½	All worked in places, but when galleries are driven in, only the lower part of seam is extracted; discontinued from want of facilities for transport of coal.
......	......	......	......	......	......	......	
......	......	......	......	......	13	13	Not worked since 1858.
......	......	......	......	......	4	4	
......	......	......	......	......	3	3	
......	......	......	......	......	7	7	Coal in 1860 only raised for private use.
......	......	......	......	......	3	3	Not worked since 1858; coal inferior.
......	......	......	......	......	3	3	
......	......	......	......	......	......	......	
	......	......	......	......	7 & 3	All	About one-third of total out-turn consisted of rubble coal.
300	......	......	......	......	3	3	Ceased working, owing to cost of transport.
	......	......	......	......	5	5	
	......	......	......	......	19	19	
......	......	...	......	......	7	7	Only 1,800 maunds removed; cost of carriage too great.
......	......	......	......	......	11	8	
......	......	......	......	......	16	16	
......	......	......	......	......	3 to 8	All	Only 2,700 maunds removed; cost of carriage too great.
......	......	......	......	......	9	9	
......	......	......	......	......	14	14	
......	......	......	......	......	17	17	

List of the Collieries worked in India during the years **1858-1866,** *with*

Name of Colliery.	Method of working.	Number of Pits or Quarries worked.	Date of Establishment of Colliery.	Out-turn of Coal in				
				1858.	1859.	1860.	1861.	1862.
Kurhurbali	Pits	7	1858	4,000	1,08,182	2,75,256	2,63,705	2,75,661
Palamow	Quarry	......	......	......	28,648	30,900	33,343	43,772
Cherra	Drifts	......	......	10,253	18,731	24,843	16,167	......
Lakadong	Ditto	......	1839-40	12,066	13,767	......	......	......
Kota	......	......	......	......	......	......	......	......
Nerbudda	......	......	......	......	......	......	......	......
Oomiét (Burkoi) ...	Quarry	1	1861	......	......	......	5,000	13,000
Lynyahi (Sind) ...	Pits	4	1857	45,300 (1858–1859)		......	......	......
Salt Range	Drifts	......	1863	......	......	......	......	......
Assam	......	......	......	......	......	......	......	......

N. B.—These returns are avowedly incomplete.

statistics of method of working, out-turn of Coal, &c., &c.,—(continued.)

Maunds for the years				Steam Engines and Horse Power.	Thickness of Coal Seam in feet.	Thickness of Coal worked.	Remarks.
1863.	1864.	1865.	1866.				
25,386	......	......	......	14-H. P. / 18-H. P.	8 to 16	All	Suspended January 1863, owing to want of means of transport for coal.
......	......	......	......	......	......	......	Not worked since 1862.
......	......	......	......	......	4 to 6	All	Closed in 1861 on account of the "unprofitable and risky nature of the business."
......	......	......	......	......	4 to 6	All	
......	......	......	......	......	......	......	No information.
......	......	......	......	......	......	......	Ditto.
7,000	4,000	......	29,920	......	8½	7	
......	......	......	......	......	......	......	Merely a nest, which did not extend a stone's throw from the pits in any direction.
199	9,742	27,528	14,596	......	......	......	From several places.
......	......	......	......	......	......	......	No returns.

APPENDIX I.

REPORT ON THE COAL AND IRON DISTRICTS OF BENGAL.

From DAVID SMITH, ESQ., *Government Iron and Coal Viewer, to the Secretary to the Government of India Public Works Department,—Dated Nainee Tal, 2nd July* 1856.

I have the honor to submit herewith my report on my investigations of the districts visited by me in Bengal during the past season, and hope the observations I have made on the minerals and the other matter connected may be approved of.

Report by DAVID SMITH, ESQ., *Government Iron and Coal Viewer, dated 30th June* 1856.

In accordance with the instructions given me by Lieutenant Colonel W. E. Baker, Secretary to the Government of India Public Works Department, dated 9th November 1855, I proceeded, as soon after the receipt of the same as I could complete the necessary arrangements to examine the several mineral districts assigned me.

I commenced my investigations in the Damoodah Valley, and with the view to acquaint myself with the general features of the country, did not at first confine my attention to any one particular locality, making as extensive a tour over the whole as I could, visiting the collieries from Raneegunge to Chenacoory and Chaunch on my way.

As no doubt can exist that the supply of coal to be obtained from the extensive field of the Damoodah Valley is almost without limit and inexhaustible, and as, besides, its features and general conditions are so well known from reports already published and by the developments at the many collieries in operation, it would be superfluous for me to offer observations in regard thereto. The quality of the coal has been tested for a variety of purposes, so that its capabilities thus far are well understood. I was interested to learn whether it be suited for the manufacture of iron on the European system.

My attention was therefore directed to this point, and after the best consideration I could devote to it, I came to the conclusion that, although inferior to the English and Welsh coals, it is a safe fuel for reduction of ores in blast furnaces with the aid of hot blast. With the "lange" of the Raneegunge seam, an imperfect coke may be produced, but from the great amount of " wastage" or bad yield in the operation, it would be too costly a fuel for profitable application. It would consequently have to be introduced in its raw or natural condition, in which form, with the blast heated to 600 degrees fahrenheit, a temperature easily obtained, I should apprehend no danger for a result satisfactory, so far as concerned the quantity of pig or crude iron produced.

The fuel is a most important element in the working of a blast furnace. This is illustrated more clearly in the iron districts of Wales than in either Staffordshire or Scotland, inasmuch as in the two latter the coal throughout is of nearly uniform quality, whereas in the former there are three distinct kinds of coal used for

the manufacture. On the eastern end of Glamorganshire and extending into the adjoining country of Monmouth, the coal is highly bituminous, very durable, performing a high duty, or in technical terms, capable of bearing a heavy pillar of blast, and carrying a heavy burthen of ore; that is, a given quantity of coal will reduce an unusually large proportion of ore. In this district it is common for one furnace, with hot blast, to turn out 160 to 180, and even 200 tons of pig iron in a week of seven days. Of course the iron is of low quality, but nevertheless it is all worked up into rails and merchant bars. Westward from the locality now referred to, and near the centre of Glamorganshire, a coal of a totally different character is found, having no bitumen whatever: it burns freely, with abundance of flame, but no smoke: this is the well known "steam coal" of Merthyr-Tydvil and Abudare. In this locality are also important iron works dependent on the coal now described, a fuel peculiarly pure, although incapable of performing equal duty in the blast furnace to that worked to the eastward. The difference in the produce is very great, for with furnaces of equal size and the aid of hot blast and iron ore of equal, if not superior, quality, the "make" per week in this district will not average more than 100 tons, a great falling off when compared with the produce of the Monmouthshire furnaces and those established at the bituminous coal field of the South Wales Basin.

The third description of coal used in Wales for the manufacture of iron, is the anthracite or stone coal, found still further to the westward, extending through Caermarthenshire into Pembrokeshire. Anthracite coal is hard and dense, the fracture brilliant; it is a refractory fuel difficult for that reason to deal with; but when fairly ignited, gives great heat and is very durable: it burns without smoke or flame. Many attempts were made, commencing as far back as forty years ago, to apply this coal to the reduction of the ores in the districts, but uniformly without success, till the iron-making community were startled by the Scotch iron-masters, who, by simply heating the air before its introduction to their furnaces, quite quadrupled the make.

The wonderful effects produced suggested to the mind of a spirited proprietor of iron furnaces, situated in the anthracite districts, but worked with bituminous coal imported, the possibility of using this hitherto condemned fuel by aid of the then new application. After encountering and overcoming many and unexpected obstacles, by altering the size and form of his furnaces, and by the erection of an efficient heating apparatus for the air, his energy and perseverance conquered, and he was fully rewarded for his expenses and trouble by complete success; the fuel till then looked upon as utterly intractable, is now used with the same facility and certainty as the others.

The coal worked at the several collieries in the neighbourhood of Raneegunge is of a very peculiar kind, the seam being composed of the three qualities referred to—bituminous, free-burning or steam coal, and anthracite, in repeatedly alternating thin layers. In this respect it is different to any seam that has come under my observation at home; nevertheless it ignites readily, burns freely, and although not so durable as the best of the Welsh and English coals, gives out a great amount

of heat. After mature consideration, I am led to the conclusion, which I feel I can state with much confidence, that this coal would be found very manageable in the blast furnace under the conditions I have already stated; and that with a properly constructed furnace, efficient blast power and heating apparatus, a weekly produce of from 65 to 70 tons might safely be calculated on, with no other ores than those to be obtained from the neighbourhood, and of a quality well suited for railway and merchant bars for all ordinary purposes. For the several processes at the forge and mill, the coal is admirably adapted, inasmuch as for each the great essentials are a fuel that burns freely and with a clear flame—characteristics possessed by this coal.

I do not think I can profitably add further observations in regard to the coal; I therefore proceed to detail my investigations of the iron ore fields. I will first remark on a somewhat peculiar kind of iron ore distributed pretty well all over the surface covering the coal. It has been very properly designated ferruginous gravel, a term which conveys a correct description of its appearance; it is argillaceous, and singular enough, is precisely like the ore used in France, on which the iron works in the neighbourhood of Boulogne and others to the south are entirely dependent. In France it lies near the surface, the covering generally not exceeding 3 or 4 feet, being found in "beds" or rather "lodes," for they are not continuous, varying in depth from 3 feet to 12 and even 15 feet. During my survey in this country, I have not met with similar deposits of this ore in more than two or three places, and there the thickness did not exceed 3 feet; but that it is to be obtained in considerable quantity is shown by the large heaps collected for the repair of so many miles of the Grand Trunk Road. It is a valuable ore and would be advantageously used with the other clay ores of the districts in the manufacture of iron, a purpose to which it would be more properly applied than to its present uses. It is to be hoped that the day is not distant when this ore will be too fully appreciated to admit of its use as a material for making and mending roads.

The iron ore field of Barrool is situated about 8 miles to the north of Raneegunge, and was the first, the investigation of which occupied my attention. In styling it "Barrool," I do not mean that the district examined is comprised within its limits, properly speaking; for Barrool, like other localities in the neighbourhood, is a village with a certain amount of land attached. The fact of its being perhaps rather more important and better known than any other induces me to adopt it for convenience, thereby avoiding the repeated introduction of names of places known only to those living on the spot; therefore, by giving the title of Barrool to this field, I wish to be understood as referring to a tract of country bounded as follows :—

Chooroolia on the north, approaching the Adjie River; Jamsol, east; Sottoor, west and south, to within half a mile or thereabouts of the village of Rajpore; the extent from north to south being 4 miles and from east to west nearly 5 miles. The southern boundary approaching the village of Rajpore is distinctly defined by a sudden and abrupt alteration of the angle of inclination in the strata. I do not mean that the *direction* of the "dip" is changed, but that from being

comparatively flat, the inclination at this point suddenly assumes a very steep angle, a feature which holds its course from east to west across the entire field and beyond its limits. To this circumstance is due the appearance of the iron ore at Barrool, as but from the "up-heaving" described, the coal measures would have held their course to the north with the same easy rise, and thus have occupied the ground at Barrool, where now are presented the deeply (geologically) underlying seams of iron ore.

Traversing the tract in question and going northward, the first indication of iron ore observed is from the surface being thickly strewn with lumps of it. A section, not a deep one, of the iron bearing strata, is exposed in a stream or rivulet less than half a mile to the west of the village of Barrool, where are shown two seams of ore, the upper 8 inches, and the lower 9 inches thick, with a course of nodular ore averaging 3 inches—these I traced for a considerable distance down the stream towards the north-east. I found the same near to Jamsol, the extreme eastern boundary of my search ; and afterwards in the west, not far from Sottoor ; these seams have likewise been exposed at a variety of intermediate places, by the operations of the Natives digging tanks and shallow wells. In all and every one the ore was found, so I had no difficulty in feeling satisfied of its extending over the whole of the tract of country comprised within the limits of the boundary I have set down.

These seams alone would not be of sufficient importance to warrant mining operations ; I consequently applied for and obtained the sanction of Government to sink a trail shaft.

The site fixed for this shaft is on the bank of the small stream already referred to, about half a mile to the west of the Barrool village. While I remained in the neighbourhood, it was sunk to a depth of 32 feet, intersecting to that depth four seams of iron ore of the aggregate thickness of 18 inches, which, with the seams before known, makes a total of 38 inches of clay iron ore of very superior quality. In addition to these, a vein of carboniferous iron ore, known at home as "black-band," was passed through 3 feet 6 inches thick ; it is not by a great deal so rich an iron as the Scotch black-band, as I estimate it to yield no more than from 20 to 23 per cent. in its raw state, but when calcined, a process which this ore, as well as all the clay ores found here, must go through before introduction to the blast furnace, I believe it will yield over 40 per cent. of iron. It is not all equally good, the lower 2 feet of the seam being the best. The great advantage of these ores (black-band) is the comparatively small cost at which they are worked, and the greater fusibility. Mixed in fair proportion with the clay ores, the process of smelting is facilitated, increasing consequently the "make."

When the trail shaft had reached the depth given, 32 feet, I was ordered to proceed to the other districts assigned for examination, and to place the pit under superintendence during my absence, as I should be at too great a distance to exercise supervision over it. Mr. H. Biddle, of Raneegunge, was good enough, on my application to him, sanctioned by Government, to undertake the charge. Under his superintendence the pit has been continued to a depth, as reported to me by Mr. Biddle,

of 51 feet 11 inches; another seam of ore, 2 feet 4 inches, and by analysis containing 42 per cent. of iron, being discovered; so that in a shallow section of 52 feet, we have 38 inches in separate beds of excellent clay iron ore and 52 inches of carboniferous or black-band iron ore. I do not now take into account the upper and inferior portion of the first seam of black-band met with.

No doubt can exist that where the upper beds lie, those below as found in the pit will be found co-extensive. It follows, as a matter of course, all the beds of ore discovered, as above described, both argillaceous and carboniferous, must extend under the whole of the wide field now under notice, affording a supply of ore almost inconceivable in quantity.

The clay ores, 38 inches thick, would give rather more than 1 ton of each superficial yard of surface, and the carboniferous, 52 inches thick, at least 1½ ton under a like space. Now, taking only 4,000 yards to the acre, allowing the 840 yards a most liberal allowance to go for loss and wastage in working, and for some portions of the field blank, as happens in all, we have, as the produce of one acre, 4,000 tons of the first and 6,000 tons of the second, equal to 10,000 tons of ore, and per square mile 6,400,000 tons.

Assuming 4 tons of ore to be required to make 1 ton of pig iron, a larger quantity than would be used (but I wish the statement to be over rather than under), as 3¼ tons would be a fair quantity to calculate, the ore to be obtained from each square mile shows a product in pig iron of no less than 1,600,000 tons, equal to the make of eight furnaces, at 70 tons per week for a period, in round numbers, of rather more than fifty-nine years.

I believe an opinion is prevalent in this country, that beds of ore varying from 3 to 8 or 9 inches thick cannot be profitably worked from the amount of labour required to make "head room" for the miner by removing so much of the unproductive shales as would enable him to carry on his operations for the extraction of the ore. Opposed to this is the fact, that all the iron works of Shropshire, Staffordshire, and Wales obtain their supply of what is termed Native ores from similar beds. It would certainly not pay so to operate on one thin seam, but when three or four of an aggregate thickness of from 15 to 18 inches are associated in the same range, it is found to answer well. The miners of the country would have no greater difficulty to contend with to penetrate the strata containing the ore than they have in driving passages through the coal seams, for the shales holding the iron ore are soft and easily worked—undoubtedly the one would cost more per ton than the coal that happens everywhere almost without exception. It is by comparison only that a conclusion of high or low cost is to be arrived at. At the present time the ores of Staffordshire do not cost less than 20 per ton, the average of Wales will be 13: compared with such prices, the ores of Barrool would stand very low. Taking a working over a series of years, for at the early operations the cost would be less, those ores would not, in my opinion, exceed 5. This would be due to the cheapness of labour and the facilities offered to mining operations in this district.

The frequent undulations of the surface present opportunities for mining by "patch" or open work, a very ready mode, and when practicable, always adopted in preference to the more costly system of pits and adits. Skilled miners are not required for that system of work, and another advantage is that all the ore is got out, whereas in underground mining, a portion must be left to form the sides of the passages and to support the roof.

Supposing no other seams and beds of ore to exist under the lands of Barrool and these adjoining than have been already discovered, it is, as it then would stand, a valuable iron ore field; but the great probability is, that if the search be prosecuted beyond the present superficial depth, additional deposits will be found. I do not recommend Government to continue the search any further, enough has been done to show the existence of ore in abundance; the further development may now be left to private enterprise.

THE TALDANGA IRON ORE FIELD.—The tract of country of most, indeed the only one of importance in this neighbourhood as iron ore bearing, lies on the east of the Barákar River.

Between the 146th and 148th mile-stones on the Grand Trunk Road, three or four seams of ore are exposed; the section being presented in the water-courses, running southerly to the Barákar. Through these I traced the ore to near the river, where they are lost by a depression, but as the dip of the strata is only equal to the fall of the surface, new ground is not seen. The lowermost bed of ore at the Grand Trunk Road continues the lowest all the way down the bed of the brook; the scouring of the water being further resisted by the increased hardness of the shale beds.

In extent to the north of the Grand Trunk Road it reaches about two miles, when it is interrupted by very disturbed ground. In width from east to west it is rather more than a mile.

Within these limits the strata lies with the utmost regularity, preserving a uniform "dip." Four beds of clay ore only are to be seen here, in quality very good. Wishing to satisfy myself what was below, I commenced a trial pit here also close by the Grand Trunk Road, near the 147th mile-stone. I had the greatest difficulty to obtain workmen at all equal to sink the shaft; the best I got were no better than ordinary coolies; so the progress of the pit was very slow. When I left the neighbourhood to proceed onward with my survey, 11 feet had only been accomplished, the whole depth being through black mine shale. Mr. Biddle kindly undertook the prosecution of this pit as well as the one at Barrool, but I fear, as he has not noticed it in either of his letters to me, its distance from him and his many other engagements prevented his giving attention to it; consequently I have no further information to give in regard to this district, and whether it be a valuable field or not must for the present be shrouded in doubt.

On the western side of the Barákar, about 1½ mile from the river, is another small field of iron-stone, but so limited in extent, and surrounded by disturbed and broken strata, as to be unworthy of notice.

The Native smelters on the banks of the Barákar, about 4 miles distant, obtain their supply of ore from this spot, a thin seam being found at a depth of about 3 feet.

The coal found in the immediate neighbourhood is of inferior quality.

From Taldanga I proceeded on my way to Palamow, stopping at the Fitcooree bungalow to visit Jurrhiah, a mineral district about 8 or 9 miles distant to the south.

The indications presented here were far from encouraging. The strata are very disturbed, with every appearance of an unimportant deposit of ore; thus, as no inducement was offered to a prolonged stay, I went on, arriving at Shergotty on the 10th February, where I was detained waiting for my tents and baggage till the 19th; thirteen days having been consumed by the hackeries on the march up from Taldanga. Immediately on their arrival, I started for Palamow by way of Nourangabad, arriving on the 23rd, and at once commenced my investigations of the Rajarah coal-field.

This property is owned by the Bengal Coal Company, who are actively prosecuting minings on a seam said to be 11 feet thick: to the eastward it extends for about 2½ miles: near the extremity in this direction a vein is being worked on the outcrop, not by shaft, but by "patch" or open work.

Near to the centre of the field from east to west, a very fine shaft is being sunk by the proprietors, and the energy and enterprize exhibited merit a successful issue.

Further to the west, and for some distance to the south from the new shaft, faults and dislocations are somewhat frequent, but to the east such interruptions, although not entirely absent, are not by a great deal so serious. The strength, the main dependence of the field, lies in this direction.

The coal now worked at Rajarah is different in quality to that of the Damoodah; it leaves a very red ash and does not burn so freely, but is similar to it in one characteristic, *viz.*, it will not coke.

From Rajarah I went south travelling over the coal measures to the Manut River, a tributary of the Coyle, near the junction with which on the south bank a crop is exposed of a vein 6 feet thick, with sandstone covering. To the east from here the coal measures extend over a wide tract, but on the west are cut out by a fault before reaching the Coyle. The coal here presented is not good, having a very large amount of earthy matter.

Proceeding south beyond the Manut, the coal measures are found to extend for 3 miles further, where they are again interrupted by an up-throw fault bringing up the lower strata, lying perpendicular, and so continuing to the village of Shahpore on the south bank of the Coyle, which here abandons its course of north and south, taking a direction east and west.

The same condition is maintained along the country by Chirrepore and Chandoo and through the Hill Pass to Chungha. Here I again crossed the Coyle, still preserving a direction south for about 6 miles, when the coal measures again appear: and in the Dearee Nudee at the foot of a hill named Chenra, I found a vein of coal 2 feet 2 inches thick, of very inferior quality. The strata here have a "dip" to the west, which is unusual, and may be taken to indicate a serious disturbance in this coal-field.

It is difficult of access and the population is scant, altogether inadequate to supply labour such as would be demanded if collieries were established; but supposing labour existed in the neighbourhood, or could be imported into it, the bad quality of the coal, with the heavy charge on the transport to a market, deprive this locality of all chance of successful competition with others more favorably circumstanced.

The advanced period of the season at which I found myself here, approaching the end of March, the daily increasing power of the sun, the great heat in the narrow jungly valleys, and my health failing, compelled me to relinquish my intention of a more extended search.

I returned by Chittra and Oolman, villages lying much to the west of the route I followed on my way out. Iron ore was reported in great abundance—my inducement for taking this road. I found none, however, till I reached the village of Adur, near which is a very partial deposit of magnetic ore of the very richest quality, but so limited in quantity as to be of no importance.

The examination of these two coal-fields of Palamow, that of Rajarah, and the second to the south, terminated my survey for the past season. No features are there presented at all favorable to the establishment of iron works, but the contrary; for failure only, with the attendant disappointment and loss of capital, would result from an attempt to introduce the manufacture into districts, unprovided as these are with the requisite elements, and otherwise unprepared for the reception of a manufacture of so important a character.

Having thus to the best of my power recorded all that occurred to me worthy of notice in regard to the mineral districts I have visited, I venture to offer a few general observations on the manufacture of iron and the chances of success that may be calculated on as attending its introduction to this country.

The great and incalculable benefits to result from it to India are so evident and palpable as to need scarcely so much as even a passing remark. The formation of railways, now become essential to the well-being and progress of all countries, is specially required for the development of the vast resources of India, at present lying dormant and unprofitable, or only to a very limited degree productive—a lamentable and much-to-be-deplored condition, due, it may be said, almost entirely to the absence of an easy, cheap, and rapid system of inter-communication. It is undoubtedly true, that any amount of iron may be secured in Great Britain, no matter what the form desired, whether in the ordinary one of merchant bars or that of rails; but there has to be contended with the admitted difficulty of conveyance out, not governed so much by the cost as by the impossibility to obtain

adequate freightage, thus causing delay in the progress of the work, not detrimental alone to the interests of the railways now in course of formation, but to that of the country at large. These, however, are considerations not to be expected to enter into the feelings of individual capitalists disposed to embark on such an investment; they will naturally look for a return for their capital, risk, and trouble as the inducement.

The erection of iron works under the most favorable circumstances is not to be entered on lightly. If this be true in regard to the speculation in England and Wales, it applies with especial force to India.

The management of the first process of the manufacture, that of the blast furnace, is not by any means so simple as I know many persons not conversant with it are given to suppose. To such it may certainly appear a very ordinary operation, and easy of accomplishment, to fill a large furnace with coal, iron ore and limestone, light the fire, and introduce a strong current of air to keep it up. When dealt with in practice, however, it is a process found to require the watchful supervision of an experienced overlooker, and the unremitting attention of skilled workmen. Carelessness in not putting in the proportion of each material as ordered, disregard of the twyers (the orifices through which the blast operates), neglecting to keep the crucible and other parts of the furnace within reach of the tools used clear and free by "properly working it," as the term is, are each and all causes of disarrangement and consequently of loss, commonly resulting in the total stoppage of the smelting, and it must not be forgotten that this care and watchfulness is required equally by night and by day.

The same observations will apply to the several processes of puddling, balling or retreating, and rolling for the reduction of the pig or crude iron into malleable at the forge and mill: experienced superintendence and trained labor must be had for each.

Now supposing iron works established in India, I do not mean by the above remarks to convey that I believe it essential or necessary for *all* the workmen to be Europeans. Such a conclusion, if agreed in, would at once prohibit any attempt. What is meant is, that to avoid certain failure, a few good European workmen should be employed for each department, by whom the Natives might, if capable, be practised and trained each to his respective branch.

The manufacture of iron is somewhat difficult and complicated. Its introduction into India, where it is so little understood practically, where it may be looked on as a new one, would inevitably be attended with many obstacles and difficulties. Most of them are doubtless to be overcome by ordinary perseverance and energy if directed by experience.

Some two or three, at an early period of my investigation, were presented to my mind as being of the most importance; of these I have never lost sight, keeping them always present and testing their value as often as I had opportunity.

The first then is the climate. Is it possible for any class of men, Natives of the plains of India or others, to endure, in addition to the enervating heat of the sun during the hot weather season, considerable physical exertion before intensely-heated furnaces? Having had experience of the plains till the middle of May, I confess to a grave doubt, whether it is possible. On this point I have sought the opinions of men long resident in India, whose experience is consequently entitled to much weight. Most of them have spoken confidently that the Natives can bear any amount of heat arising from sun and furnaces combined. As proof, the engine stokers (Malays generally*) of the steamers in the Red Sea were instanced. On my way out to India while in those latitudes, I more than once went down to the engine-room. The heat in front of the boilers was certainly more than an European could long bear, but neither do the Malay stokers stand long in it—their work is done by short starts, after which they invariably retire under the cooling influence of the "wind-sails," contrivances that cannot be adapted to the cast-houses of blast furnaces or to mills. The work of these so engaged is not continuous and incessant, although of longer duration than the intervals of engine tokers and much heavier weights have to be handled.

The next thing to be noticed, as having a decided importance to any mind, is the physical capability of the Natives. That they are clever manipulators I know, having witnessed the perfection of their skill in cutting the "dies" and general lathe-work at the Mint at Calcutta, where I also saw copper rolled into sheets with equal facility as if performed by the best European workmen. No doubt therefore can remain, if the Natives have the strength, they would quickly acquire the skill, necessary for all the operations in the manufacture of iron from the blast furnace, the most simple, through the forge and mill. In offering the foregoing observations in these two points, I do not pretend to give a decided opinion on either; the Natives may be able to endure all the heat they will be subjected to, and possess the required strength to accomplish "puddling" and rolling heavy lumps of highly heated iron, but what I do feel certain of is, that those Natives who engage on the occupation must *entirely* change their habits and condition; the dress of the European must be adopted, thick shoes and stout flannel clothing; without such protection they would quickly be beaten; they must eat more nourishing food than they now do, and give up their poojas and holidays of a week or fortnight's duration. Can they be brought to accommodate themselves to such a total, so radical a change in their habits, is a question deserving much consideration. It is what I cannot determine, for I have not sufficient experience of their feelings and prejudices to know to what extent they may be overcome or removed.

It has been suggested to me that Seedees and Chinamen could be imported, the former described as able-bodied, high-spirited men; if they are to be had, it would certainly be most desirable, as it appears to me, for I confess to an opinion not by any means favorable to Bengalees as being suited for work so arduous. High

* They are Africans almost universally.—*Ed.*

pay, as I believe, would not instil into their minds energy and am
nor be a temptation to them to throw off that listlessness, apath
lethargy fatal to their advancement and improvement; their wan
too few and too easily supplied to offer an inducement to them to
on a new occupation, demanding, what they have never yet exe
the utmost of their physical powers for accomplishment.

In reverting to this part of the subject, the establishment of
works in India, my mind is entirely directed to the dist
Raneegunge and Barrool, the one containing coal, the other iron o
what may be spoken of as inexhaustible abundance.

This is the only locality I have visited presenting chance
successful issue. The working population is trained and disciplined
would be readily available for the minor and less important dema
iron works, having besides the great advantage of absolute conn
with the railroad.

All these are features much in favor of this locality, but a s
drawback, of greatly too important a nature to be passed without n
is the almost entire absence of "flux."

Kunkur lime is distributed, in often recurring patches, ov
surface here, as it is everywhere in the plains, but in quantity so defi
so far as my anxious observation led me to decide, as to be altog
unreliable as the source for the supply of even one furnace. Lime
would, therefore, have to be imported in large quantities, still not t
full extent of flux required, for all the kunkur that could be obt
would, of course, be collected to go in diminution of the quantity
of the highly expensive article to be imported.

This would be still further reduced by using over again the s
or cinders of the blast furnace. This is not a speculative op
inasmuch as I have commonly applied the scoriæ to the purpose of
works at home. It is not there generally practised, from the triflin
at which nearly all the works obtain a supply of limestone.
however, it would be different. The imported flux, instead of bein
cheapest, becomes the most costly material in the manufacture, a
cannot be unfair to assume that, when in practice, other means than
alluded to would be brought into use, by which the consumption
costly an article might be greatly economized.

The first attempt to establish the manufacture in India would
certainly be a spirited undertaking, and would most likely be lo
upon by those entering in it as an experiment. It is, however,
hoped, those who engage in the speculation will not treat it as "ex
ments" too commonly are, *viz.*, by trying to produce satisfactory re
from temporary, and therefore deficient, erections and patch-work co
vances. Such a proceeding is to introduce at the commencement
elements of failure, in the end leaving all in as much doubt and u
tainty as surrounded the question before a large sum of money, so
diciously spent, had been wasted in its attempted solution, sprea
abroad in addition the mischievous impression, to last, in all probab
over many years, that other attempts would be attended with like c
quences, whereas, had the spirit which prompted the undertakin

shrunk from the somewhat larger figures demanded by the provision of efficient means, it is most likely a nucleus would be formed, round which would gradually grow an establishment capable of meeting to an important degree the requirements of the country, at some time returning fair remuneration for capital invested.

Let the trial be conducted on as small a scale as practicable, that certainly will be prudent, but even for that whatever buildings and machinery be requisite, should be of the best construction.

One furnace will suffice to solve the prevailing doubt in this country, whether it be possible to make pig or crude iron from its ores.* For myself, I may say I have not the shadow of a doubt of it. I know it can be done, to which I may add the established fact, that one furnace cannot be made to pay. The reasons are obvious; additional furnaces can be erected at much less cost than *the first*, and the charges of management and general establishment bearing too heavy on one become comparatively light when distributed over the larger surface of increased "make."

According to the view I take of it, a work only calculated to make pig iron would not answer, a market for it in that form not existing, as I am informed, capable to absorb the make of one furnace. The manufacture must therefore be carried further into malleable iron, merchant's bars and rails, thus becoming a formidable matter, involving a heavy outlay, a circumstance, however, I expect, that would prove not to be an obstacle, if confidence were established in the investment.

The question of cost and profit can only be determined by a comparison with the cost at the iron works of England (and by England I mean the works generally of Great Britain).

Although at so great a distance, these will prove formidable rivals for some time to the infant establishment out here.

The Railway Companies and their Engineers in England have taken advantage of its immense producing power, and consequent competition, to beat down prices, forcing the iron masters to the exercise of their ingenuity, to turn out a cheap rail. In this they succeeded by a clever contrivance, producing a rail, in external appearance perfect, but in reality composed of at least eight-tenths of the cheapest, and therefore worst, iron that could be produced; the consequence is—what was to be expected—renewal of the rails at a much earlier period than calculated on.

As long as this system prevails of requiring *cheap* iron, it must operate against India, for no wider margin can be had in favor of Indian profits than is afforded by the expense of conveyance from England out. The cost of iron to be manufactured in India cannot, for years at all events, be less, or so low as in England, but this will be better seen in the cost of English iron and the estimate for that of India attached to this report.

The quality of the iron made here would undoubtedly be very superior to that now used in England for rails, but whether the Directors and Engineers of Indian Railways would set a good example to those at

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* This never was doubted.—*Ed.*

home by paying for quality, I cannot pretend to say. A feeling, I believe, is gaining ground among these gentlemen, that it will be better to have a stringent specification, paying a price enabling the iron masters to adhere to its stipulations. Once the new rule is adopted, Rail Inspectors may be dispensed with, and India compete on more equal terms than she could do under existing circumstances, for the higher the price of English iron, the less interference will that of India meet with from it.

An advantage to English iron masters likewise arises from the circumstances of the fluctuations in the selling price being followed by a corresponding alteration in the rate of wages; thus, if the selling price be low, so also is the cost, a rule that cannot obtain place in India till the relative position of master and workmen be on the same footing as in England.

As a work on a very limited scale, the smallest that can be had can only answer one end. To test the value of the materials, it remains for me to state my idea of what should be the extent of establishment from which profit might be expected, while confining it within the narrowest limits compatible with such a result.

Thus then I believe no hope of profit can be entertained from a less establishment than two blast furnaces, producing say 140 tons per week, with forge and mill power equal to the conversion of such quantity into malleable iron, leaving nearly 100 tons per week in this finished form to be disposed of.

It is on this basis I shall found the calculations of cost of erection and the estimate of profits.

Before concluding my observations, I would beg to suggest that, in the event of a work such as is proposed being commenced on, it should not be hurried to completion; such an end could only be obtained by increased heavy outlay, occasioned mainly by the extra number of European workmen that must be brought out. It will be more prudent to proceed gradually, expending time rather than money; but lest I should be misunderstood, I do not contemplate more than two years as being required. While the furnaces are in course of erection, the machinery for the forge and mill could be ordered and sent out in parts, commencing with the "puddling," and so on through the several processes. By this arrangement one department at a time only would occupy the attention of the manager, and be perfected, or nearly so, before he would be called on to engage in the succeeding one—an indisputable advantage when an operation requiring skilled hands has to be gone through with the aid of those untrained.

I now proceed to give an estimate of the expense of erecting a work on the plan suggested, and as it appears to me the most convenient mode, shall open the outlay required for such an establishment in England, adding to that a percentage to meet the extra charges of transit to India and for fitting machinery, &c., after arrival.

I do not include in my estimate the outlay for mining of coal and iron ore, that part of the expenditure at iron works at home constitutes a large, if not the largest, proportion of the capital invested; and as there is nothing relative between the operations in the two countries, I

think it best to omit any notice of it; besides, it would be most difficult to give an estimate approaching the truth, from the conditions and circumstances controlling the sinking of shafts and driving adits being so various.

Estimated Expenditure for an Iron Work in England equal to a weekly make of 100 *tons of finished iron.*

	£	s.	d.	£	s.	d.
Two blast furnaces, with hot air apparatus ...	2,000	0	0			
High pressure blast engine, with main blast pipes	2,300	0	0			
Engine house	600	0	0			
Cast house	300	0	0			
Sheds at top of furnaces, &c.	120	0	0			
Contingencies	200	0	0			
				5,520	0	0
Cost of forge and mill.						
Machinery, including steam engine ...	5,000	0	0			
Erecting ditto ditto...	300	0	0			
8 puddling furnaces	800	0	0			
5 balling or re-heating ditto	500	0	0			
Flooring plates, cast iron, say	120	0	0			
Roofing and side walls	250	0	0			
Contingencies	300	0	0			
				7,270	0	0
Add for management for one year—						
General manager, per annum	400	0	0			
Furnace ditto, ditto	120	0	0			
Forge and mill ditto, ditto	200	0	0			
				720	0	0
				13,510	0	0
Add for conveyance of machinery to India and for extra expense of erecting one blast—						
Furnace engine	2,300	0	0			
Forge and mill machinery	5,300	0	0			
	7,600	0	0			
At 30 per cent.				2,280	0	0
Total cost of furnace and machinery				15,790	0	0
To which must be added expense of Indian management for two years, *viz.*:—						
General manager, per annum	600	0	0			
Furnace ditto ditto	300	0	0			
Forge and mill ditto, ditto	400	0	0			
				2,600	0	0
Passage out				300	0	0
Forge and mill for European workmen as under:—						
One founder ... / Three puddlers ... / Two roller-men ... / Two ballers ... } at £60 each				480	0	0
				19,170	0	0
Deduct English management charged on erection ...				720	0	0
				18,450	0	0

Estimated cost of rails, if manufactured in India.

	£ s. d.	£ s. d.
COST OF PIG IRON.—Iron ore, 3¼ tons, each 5*s.* ...	3 0 16	
Large coal, including consumption of engine and hot blast, 4 tons, at 4	0 16 0	
Limestone, 15 cwt., at 27	1 0 0	
Furnace wages	0 5 0	
		2 17 3
PUDDLED BARS.—Pig iron, 23 cwt., at 57-3 ...	3 5 10	
Coal, 20 cwt., each 4	0 4 0	
Wages	0 8 0	
Rolling	0 3 0	
		4 0 10
RAILS.—Puddled bars, 21½ cwt., at 80*s.* 10*d.* ..	4 4 10	
Coal, 15 cwt., at 4	0 3 6	
Ballers' wages	0 4 0	
Rollers' ditto	0 5 0	
Cutting and piling	0 0 9	
Mill engine and wages, including coal ...	0 3 0	
Sawing and straightening rails	0 1 0	
General labor and repairs	0 2 6	
Wear and tear of machinery	0 4 0	
		5 8 1

Estimated profits of the proposed Indian Iron Works.

The selling price of rails at the present time in England may be taken at £8, the freight to Calcutta would certainly be not less than 20*s.* per ton, thus the rails will cost £9 per ton.

The estimated cost of Indian-made rails comes out at £5-8-1 per ton, but I will take it at £5-10, showing thus far a profit of £3-10 per ton; and on the make of 100 tons per week, for say 45 weeks, a gross return on the year of £15,750.

From this deductions must be made as under:—

Gross return for the year		£15,750 0 0
Deduct interest on outlay say £19,000, at 10 per cent	1,900 0 0	
Ditto on floating capital, say £5,000, at 5 per cent	250 0 0	
Management as stated	1,300 0 0	
And for incidental expenses, that cannot well be calculated, such as interests and discounts on the trading, &c., say	1,000 0 0	
		£4,450 0 0
Profits at present prices	...	£11,300 0 0

But as the trade in England is subject to so many fluctuations, and I do not believe the selling price will ever be much higher, if at all, than rules at this time, I will take the mean between the highest and lowest.

If the price at home goes down to £6, it will be in Calcutta £7, so the return in that event on the Indian manufacture will be only 30 per ton, or per annum £6,750.

The average between the higher and lower return will be £11,250, from which is to be deducted £4,450, leaving the sum of £6,800 as the average profits on outlay and floating capital after deducting interest on both.

The average cost of rails in England at the present rate of wages will be as near as may be £5-5 per ton at the shipping port, and supposing the details entered into, which I cannot conceive necessary, from the gross return at that cost would have to be deducted interest on outlay and capital, as has been done in arriving at the probable return on the Indian manufacture, with the difference, however, that at home the practice is to charge only 5 per cent. as interest.

In reference to my estimate of the cost of pig iron, I wish to explain in regard to the cost at which I calculated the limestone, that I adopted the scale of Messrs. Williams and Oldham. I sought information for myself on this point, but was unable to obtain any I could rely on.

In offering the foregoing observations on the manufacture of iron in India, and in drawing out the estimates, I endeavoured to divest my mind, and I believe successfully, of all prejudices, or preconceived ideas, and to avoid casting a high colour on any point treated of.

I feel the fullest confidence, assuming the obstacles and difficulties I have dwelt upon not to be deserving of the weight I attach to them, and no one would be more glad than myself to know they are imaginary, that in the event of a trial in the scale, and under the conditions I have tried to explain being made, a *worse* result than I have shown will not be the consequence.

As yet it is all matter of opinion, and therefore subject to the expression of many doubts, and to be canvassed for, or against, according to the views taken. This uncertainty will ere long be cleared away, for I am justified in saying that the Bengal Coal Company have determined to solve the question, active preparations being now made by them to erect, without delay, a blast furnace on their property at Raneegunge. That will not, however, do more than determine the possibility to accomplish the first step, the success attending which will, of course, govern the further prosecution of the undertaking. All who have the welfare of India at heart will watch the progress with interest, and if not in positions to offer substantial aid, will sincerely desire that result tending so materially to supply the great need of the country, easy and rapid communication, reducing days to hours for those who have to cross its wide plains and extending the field of commercial enterprise by developing sources of wealth, unavailable alone from the want of access to the localities from which, under altered circumstances, it could be extracted.

From Lieut.-Colonel W. E. BAKER, *Secretary to the Government of India Public Works Department, to Chemical Examiner to Government,—Dated 4th July* 1856.

I am directed to forward herewith, for analysis, two specimens of iron ore from a trial pit sunk at Raneegunge, and to request that you will have the goodness to report the result of your analysis for the information of Government.

From F. N. MACNAMARA, ESQ., M. D., *Chemical Examiner to Government, to Secretary to the Government of India Public Works Department,—Dated 6th August* 1856.

With reference to your letter of the 4th July, I have the honor to report upon the specimens of iron ore therewith sent.

The specimens are impure carbonates of iron and resemble the black-band ironstone of Great Britain.

No. 5 contains 38·8 per cent. of metallic iron, of which about 31 per cent. is present in the form of carbonate of the protoxide, the remainder of the iron exists in the ore as peroxide.

No. 8 contains 40·5 per cent. of metallic iron, of which about 33 per cent. is in the form of carbonate of the protoxide, the remainder in the state of peroxide.

No. 5 contains 10·13 per cent. of lime; No. 8 very nearly the same proportion.

APPENDIX II.

REPORT OF THE SIGROWLEE AND KURHURBAREE COAL FIELDS.

From DAVID SMITH, ESQ., *Government Iron and Coal Viewer, to Secretary to the Government of India Public Works Department,—Dated Calcutta, 13th April* 1857.

I have now the honor to hand you my report on the two districts—Sigrowlee and Kurhurbaree—visited in obedience to the orders forwarded to me during the past cold season.

I left Nynee Tal on the 1st November to examine localities at the foot of the hills, as ordered by His Honor the Lieutenant-Governor of the North-West Provinces, going thence to Roorkee under like directions. Leaving Roorkee on the fulfilment of the purpose of my mission, I arrived at Mirzapore on the 6th of December, where I was detained till the 12th, before completing arrangements for conveyance. Having done so, I commenced the journey to Sigrowlee on the evening of that day, and on the 18th crossed the Kymore Range by the Kawaiee Pass, where a fine bold section of red sandstone is presented; the dip of the strata being at a very easy angle, south a little west for two-thirds of the distance down to the plain of the valley of the Soane,

when it suddenly changes to a steep inclination, preserving, however, the same direction, thus interrupting the course of the bed of rock from occupying the valley below, where now in lieu is a rich and deep alluvial deposit, highly cultivated, extending for nearly the whole distance, six miles from the foot of the Kawaiee Pass to the Soane River—affording from the summit of the pass the pleasing prospect of fertility and abundance—the more forcibly by contrast with the adjoining rough and barren range of mountains.

Crossing the Soane to Chossun, on the south bank, the strata are found to be very shattered and contorted, limestone in masses being mixed with gneiss and granite,—a condition that is maintained along the deeply undulating country, nearly to Oobra, on the Rehund River—a distance of about 12 miles.

At Oobra, a change is effected by a remarkable dyke, holding a course north and south, composed of a conglomerate of iron-stained quartz, flint and sandstones of different degrees of hardness, most firmly cemented, forming a prominent feature, inasmuch as this extraordinary combination of materials—each foreign to the other—is elevated to pinnacles ranging from 100 to 400 feet in height.

To the west of this dyke at Oobra, I found in the jungle not far from the river a considerable heap of iron slag that must have been deposited there long since, it being overgrown with grass.

The slag heap being evidence of the proximity of iron ore, I endeavoured to ascend the adjoining hill in search of it; but was forced to give up the attempt by thick jungle and large blocks of stones strewn on the hill side. On returning to my tent, I sought information from the villagers, numbering five families, without success. They were ignorant of the existence of the slag heap, and had no knowledge that iron smelting had at any time been conducted there.

The slag heap is, however, sure proof that at one time iron was made at Oobra, the smelters being doubtless attracted by a near—although it does not follow important—deposit, the requirements of the Native furnaces being easily supplied from a very partial distribution of ore.

At Oobra, the Rehund—a river of considerable width—is crossed on the way to Muggerdah, the features of the country being the same with a change in the strata to micaceous slates and shales intersected by seams of quartz frequently met with in masses.

Between Muggerdah and Bilwadah, another change occurs near to the latter place. The slates are lost, and the ground occupied by a coarse stratified conglomerate, approaching in appearance to milstone grit, iron-stained, the same being found nearly all the way to Gurwhar. A little before reaching Gurwhar, the hilly character of country gradually subsides to the plain of Sigrowlee, some 40 miles in width from east to west, and 35 miles in length to the south. The boundary on the three sides is a continuous mountain range.

Passing Gurwhar south towards Kotah, when opposite the village of Ceirwah, in the closely adjacent hills to the west, is first shown the light grey soft sandstone I have always seen as the covering of the coals of India. From this point Kotah is distant 6 miles to the south, and within half a mile of the boundary of Shaipoor Sigrowlee.

Near to Kotah, a mine has been opened and worked for some years, although not extensively, on the only seam of coal as yet discovered in this field. When I was there, the mine was inundated, so I could not go in to see it. I employed men to sink a shaft on the vein, with the view of satisfying myself by personal inspection of its thickness and general features; but, after a week's work, I was convinced it would require three weeks or a month to sink to the seam—a longer time than I could afford to wait. I was, therefore, obliged to be content with the following section of it, supplied me by Mr. Burke, the Superintendent of the colliery, and which I believe may be relied on as correct :—

Section of Kotah vein below sandstone covering.

		Ft.	*In.*
Light colored plastic clay		1	0
Sandstone with slate, alternating		7	0
Clay slate, micaceous		0	6
Bituminous shale		1	6
Coal	} Kotah vein	1	0
Bituminous shale		0	8
Coal		1	6
Very hard sandstone, Kotah vein		0	1
Coal		1	6
Clay slate		0	6
Coal shale		0	3
Coal		0	9

This section shows the vein at Kotah to be not favorable for working, as the aggregate of the coal workable is but 4 feet, to obtain which the 10 feet of mixed ground lying immediately over it has to be removed,—an undue proportion of waste even when carried on by open patch-work, and much in excess to admit of fair profit in an underground working, where the spoil has to be wrought by a more expensive process, and nearly the whole of it conveyed out of the mine. As Mr. Burke assured me, it could not be made available as the roof of the mine, for, when tried, it quickly gave way, falling in masses, endangering the lives of the miners, some of whom were killed, and several seriously injured during the attempt to save the heavy expense of its removal.

Now, although the section given doubtless represents correctly the form and condition of the seam at the spot where it has been worked, I am of opinion that many localities much more favorable might have been fixed on in the neighbourhood for opening a colliery than that selected for the Kotah mine.

The form of the surface, as a rule, I do not mean without exception, is indicative of what may be expected under it; undulations and depressions above, have most commonly corresponding irregularities in

the strata below; and to the fact of the Kotah mine having been opened in such a position (that is, in a hollow between hills), is due, I believe, the unfavorable features presented by the seam.

I am confirmed in this view by tracing the same vein into Shaipoor Sigrowlee, about six miles in a direction south-west from Kotah, where a section of it is exposed in the hill side at Toorah, about 150 feet perpendicular above the plain, and nearly opposite the village of Nowah Nuggur. There the vein, in sound undisturbed ground, is nearly nine feet thick, of clean coal, with not more than a foot of black shale between it and the sandstone; and if the coal was sought for at Kotah, in a like position, that is, under the hills and not in the hollows between them (for the "dip" being northerly the coal at Kotah lies below the level of the plain) little doubt can exist the seam would then be found *in one solid bed, and not divided into layers* so unfavorably *exhibited in the Kotah mine.*

At Kotah, the coal-field is about 1½ mile in width, from east to west, that is, so much of it as lies within British Sigrowlee. To the north it reaches to within two miles of Oondhee or about ten miles, and although not free from faults and dislocations, some of them important, it would be as a whole a valuable field if it had easy communication with a market; the present heavy cost of transports seriously limiting the working; there being no means of conveyance save that afforded by pack bullocks, each carrying three maunds to Mirzapore—a journey occupying about twenty days.

In quality, the Kotah coal is good; it burns freely, with a clear flame, leaving a white ash, but will not coke by the ordinary means. In a closed retort it may, like the coals of the Raneegunge district, be so converted; but that is a mode that cannot be profitably adopted unless manufactories were established, requiring large and highly heated furnaces, the spare heat from which could easily be applied to the retorts.

While staying at Kotah, I examined the coal-field into Rewah, going westward to Pudree, a distance of about 18 miles. The coal extends the whole way and beyond, but not in a continuous field; it may be more correctly described as a succession of basins, almost each undulation of the surface causing an interruption.

At Pudree a mine was in work, not by shaft but open patch, the coal being 21 feet in thickness, abruptly stopped to the north by the upheaving of the lower measures about 500 yards from the mine, this excessive depth of coal proving this to be in one of the basins spoken of.

The Rajah of Rewah claims a right to the minerals in his territory, and I was informed is very jealous of Europeans having any settlement there,—a feeling that will prevent a renewal of the existing short license for working at pudree.

This coal-field geologically is one, the largest portion of it being held in the independent territory of Rewah; the next in extent being in Shaipoor Sigrowlee, owned by the Rajah of Sigrowlee, who, I was told, holds there a large tract of country comprising about 700 villages;

the third and least section of it is within British Sigrowlee, likewise possessed by the same Rajah, who has let the whole of this portion of the field to Messrs. Hamilton and Co., of Mirzapore, under an interminable lease.

My researches over this ground failed to discover deposits of iron ore of value. At Ning-gaee, in Rewah—midway between Kotah and Pudree—I met with one smelter, he with his family being the only residents, who supplied his solitary furnace with a very poor ore, highly siliceous, found in thin threads in the interstices of the rock close by, and picked out with much labor. In the mountain-streams flowing from Rewah into Sigrowlee, I picked up pieces of very rich ore, evidently brought by the torrents during the rains from a long distance.

I had a desire to cross the plain of Sigrowlee from Kotah to the hills on its eastern side, with the view to examine that range; but careful enquiry satisfied me the route was not practicable. The first 5 miles over the plain would be easy enough; but the remaining 35 miles or thereabouts is mostly jungle, intersected by deep ditches impassable for horses and bullocks; besides I should have had to carry with me a supply of provisions for several days, which I had not the means of doing. Being thus compelled to abandon my intention of returning by the eastern range of hills from Kotah, I left that place on the 6th January for Gurwhar, and the next day proceeded to Oondhee.

About four miles south of Oondhee, and opposite to the village of Ghursaree, the strata in the hill bends down to the plain. A mile nearer Oondhee the path crosses the Deuree Nuddee, where the upper sandstone covering of the coal is exposed, continuing with regularity for nearly another mile, when in the Deauhar Nuddee an upthrow from the plain to the north-west is distinctly shown entirely cutting out the coal.

The road from thence to Oondhee lies over the lower series, and continues into Rewah, the pass being through a remarkable, though not wide opening in the Bicheree hill, the high and perpendicular walls of gneiss having the appearance of the work of design, rather than what it is, an accidental rent from convulsion.

Returning from Oondhee to Gurwhar, I proceeded eastward by way of Myree and Ballaree, the path lying through jungle. Gneiss and granite are the only rocks exposed and much contorted, this continuing without change to Jhairoo.

Nine miles north-west from Jhairoo is the village of Kirahee, an iron-making locality, there being fourteen smelting furnaces kept constantly at work, the ore for which is obtained from the little hill or knoll called Dhew Puckla, about three-fourths of a mile east of the village.

The ore is of three kinds—one micaceous, another siliceous, while the third and smallest portion of the deposit is argillaceous.

This deposit lies perpendicular in width ten feet, confined by sides of hard micaceous slate. The bed of ore is intersected by a seam of calcined quartz, one foot in thickness, the whole bearing strong evidence of powerful igneous action.

The Native smelters consumed 40 seers of ore to produce seven seers of crude iron—an unusually large proportion even with their imperfect process; but the ore is not rich, nor is it easily fusible. It is likewise an insulated deposit, not extending beyond the narrow limits of the knoll in which it is worked.

The smelters told me they each pay to the Tuseeldar of Doodhee one rupee and four annas per annum, for the right to work ore, and for the land occupied by their huts and furnaces, which they believe to be a Government tax.

From Jhairoo to Doodhee and over the Jharookar Pass to Rone, thence to Hurdee on the Soane, the features of the country are without change. With the exception of partial cultivation in the immediate neighbourhood of the villages on the route, it is all jungle, the strata principally gneiss, with some granite in a very shattered and contorted condition.

Although, for the reason given, I was unable to examine the range of mountains forming the eastern boundary of the Sigrowlee plain, from the southern extremity, I passed over a good portion of their length to the north from Ballaree by Jhairoo, Doodhee and Rone, but did not meet with any indications that would induce me to recommend a further search. It is possible other deposits of iron ore, such as that at Kirahee, may exist; but I am of opinion none would be found possessing a commercial value.

Having re-crossed the Soane on the 14th January, I lost no time in proceeding to Mirzapore, where I arrived on the 20th of that month, marching from there to Monghyr, which I reached on the 18th February, remaining there two days, when I continued my journey to Kurhurbaree by way of Corruckpore, Bitea and Chaki, reaching the village of Pachaurbra, two miles north-east of Kurhurbaree, on the 4th March.

From Monghyr to Pachaurbra, I did not meet with anything worthy of note. The strata is very disturbed and broken all the way, without a trace of minerals.

On the 5th March, I commenced the examination of the Kurhurbaree coal-field, and found that village to be situated on the northern edge of it. About a quarter of a mile from the village, within the field, a shaft was sunk some years ago on a vein of coal seven feet thick. The shaft is full of water, but the coal in its thickness is seen at the mouth of the adit leading down to the shaft.

A mile west from the shaft the Kankoo Nuddee is met with, the course being nearly north and south for half a mile, when it turns to the east.

The strata exposed in the Nuddee for thus much of its length, is very undulating, the seam of coal being thereby repeatedly shown, with, of course, an alternately reversed dip and at a very steep angle.

The direction of these undulations being east south-east, runs quite through this part of the coal-field to the south of the shaft, and would prove a positive bar to extended workings from the shaft in that direction.

Following the course of the Kankoo Nuddee, along that part of it running eastward, the strata is found to become regular again; and at a spot known as Doomohanie Ghât a trial pit was sunk some years since by Dr. McClelland, where the coal was found to be of the same thickness as at the shaft, namely, seven feet. This Nuddee is on the western and southern edge of this part of the field, as the coal does not in either direction cross it.

Continuing in the course of the brook still to the east, shortly after passing the Doomohanie Ghât, the strata is again very disturbed from the village of Buckseedee to that of Bhunareedee, a distance of 1½ mile. The circumstance of the disturbance from here extending north across to Pachaurbra, led me at first to the conclusion that this coal-field was comprised within the limits indicated, *viz.*, from Kurhurbaree village west to Kankoo Nuddee one mile, south to Doomohanie Ghât on the same stream, 1½ mile, and east to Bhunareedee, 2½ miles, in which case it would properly be designated the "Kurhurbaree coal-field;" and had this been the whole of it, it could not be said to be a field of value, inasmuch as, besides the undulations spoken of in the strata as intersecting so wide a portion, there are as well several small fault and dislocations branching off on both sides, not easy to describe, but the effect of which would seriously interrupt the operations of the miner.

It so happens, however, that as much of this section as is workable, constitutes only a small and unimportant portion of the whole, for south of Bhunareedee, 1 mile, and near to the village of Koldeath, the coal is seen in strata quite regular, so continuing under the village to the south as far as Ardonee, 3½ miles, and eastward to Kumalgoor Nuddee and through the Lumkee Hill to Purtadeah,—a distance not less than 2½ miles. Ardonee is the limit of it to the south, but east it extends beyond Purtadeah,—how far I cannot say, as I could not work my way through the jungle.

The whole of this tract of land is free from faults or disturbances of any kind. The inclination of the strata is very easy, dipping north-west, and lies in every respect highly favorable for working.

But here again is a property possessing within itself the elements in a high degree of economic value, unproductive by the absence of a cheap communication with a market for its produce.

The small quantity of coal that was worked from the shaft at Kurhurbalee was conveyed by bullock hackeries to Sunoog-gurrah—a distance of more than 80 miles, over very bad roads, at a cost for carriage alone of eight annas per maund—a charge that gave no chance of successful competition with coals brought up the Ganges.

The quality of this coal is different to any I have seen in India. It is bituminous, will coke well by the ordinary mode, and is therefore applicable for a greater variety of purposes. It likewise ignites readily, leaving a comparatively small amount of ash, of a light fawn color.

Although this field cannot be by a great deal so extensive as that of the Damoodah, the superior quality of the coal, the highly favorable condition in which it lies, with the important circumstance that the labor of 400 or 500 miners now resident in the neighbourhood may be commanded, constitute it one well deserving the attention of mining speculators. All that is required is to remove the only disadvantage I could discover, by providing proper communication to transform the barren and almost poverty-stricken locality, to a state of prosperity.

My attention in this district was also closely directed in search of iron ore. I only succeeded in meeting with one seam 4 inches thick, overlying the coal about 100 feet.

At Kurhurbaree this seam is worked, as also at Kumersala, near to the village of Koldeah by the smelters, ten in number, carrying on the operation at Bhunareedee.

This ore is good in quality, and is continuous over the coal in the district wherever the surface is sufficiently elevated to receive it; but in quantity much too limited to admit of a moment's consideration as connected with iron smelting on the European system.

The manufacture of iron is carried on extensively by the Natives in this district. Distributed among the villages to the south and west of Kurhurbaree are 200 furnaces; all with the exception of the few at Bhunareedee to the east, supplied with a totally different kind of ore from that found at Kurhurbaree. This ore is black and triturated, very rich, 18 seers of ore yielding 6 seers of crude iron, and is obtained with much labor by washing the sand of the Nuddees; it is likewise occasionally had by the same means from the soil on the banks.

It will be evident, without lengthened remarks, that from so precarious a supply, even when taken in conjunction with the ore at Kurhurbaree, it would be impossible to meet the demand of operations in the manufacture of iron on such a scale as would alone entitle it to be considered important.

This locality can, therefore, only be thought of as one capable of supplying coal of excellent quality, in quantity almost without limit, and at a cost at the pit's mouth, that would bear comparison with the cheapest worked colliery in the country.

I have thus endeavored to convey the result of my observations on the districts of Sigrowlee and Kurhurbaree, entering as much into detail as the circumstances connected with each admitted; and, although not within the province of my instructions, I think it worthy of remark that 10 miles west of Palgunge (that village being 8 miles south of Kurhurbaree) near to the village of Burgundah, copper ore is to be found. The people at the village have a tradition that long ago copper in large quantity was obtained from the mine.

Three years since, a shaft was commenced and sunk to a depth of 17 feet by a Mr. Mackenzie, and then abandoned, doubtless because the appearance of copper ore was not sufficiently favorable to induce further

outlay. This is certainly evidenced in what was extracted from the shaft now lying on the surface. The distribution of ore being only partial in quartz as the matrix, the specimen sent herewith is a fair sample of the heap.

I am not well enough acquainted with copper mining to offer an opinion from the prospect presented, whether a "lode" is to be expected or not; it is notoriously precarious, and no one but an experienced copper miner can detect the indications of the probability or otherwise of the proximity of a "lode."

APPENDIX III.

REPORT ON THE RANEEGUNGE COAL FIELD, WITH SPECIAL REFERENCE TO THE PROPOSED EXTENSION OF THE EXISTING LINE OF RAILWAY.

From T. OLDHAM, ESQ., *Superintendent of Geological Survey of India, to the Secretary to the Government of India, Home Department,—No.* 276, *dated* 16*th June* 1859.

I have the honor to forward, for submission to His Excellency the Governor General in Council, a report on the present state and out-turn of the Raneegunge coal-field, with especial reference to the proposal for an extension of the existing line of Railway, and in accordance with the directions conveyed to me in Mr. Secretary Chapman's letter No. 22, dated 3rd January 1859.

The detailed maps showing the geological structure of this field, so far as its examination has been completed, are in preparation, and will be submitted as soon as possible.

I have further to report that, in accordance with the sanction conveyed to me to employ a Surveyor in order to complete some portions of the map of this field, and to incur an expenditure for that purpose not exceeding Rs. 750, I have succeeded in accomplishing this end at a smaller cost, namely, Rs. 564, including all charges.

Report by T. OLDHAM, ESQ., *Superintendent of Geological Survey of India, dated* 14*th June* 1859.

The working season had already considerably advanced, when it was made known to me that there existed a pressing demand for a more accurate knowledge of the real state of the coal-field of Raneegunge and its vicinity. As soon as possible, however, I diverted to that point, under the sanction of the Government of India, two of my best Assistants, Mr. W. T. Blanford and Mr. W. L. Wilson, who had already commenced work elsewhere. They very shortly after entered upon the examination of this coal-field.

After a short time it became evident that the remainder of the working season would not suffice for the careful examination of the whole field, I therefore directed that their attention should be devoted to the portion lying to the north of the River Damooda, inasmuch as this appeared to be the only portion bearing essentially on the questions

more immediately under consideration, namely, the proper direction in which to carry a continuation of the present line of railroad so as most effectually to open up this rich and important coal-field. That portion, south of the River Damooda, remains, therefore, as yet unexamined. Of the greater portion of the field, the only available map was that surveyed for and published with Mr. Williams's Geological Report in 1850. This is a very good general map, and fully equal to the ordinary revenue survey maps of the districts adjoining, without however their detail. Of a small portion of the field at the eastern end, which belongs to the district of Burdwan, the revenue survey maps are complete, and there is also an enlarged copy of their maps on the scale of 4 inches to the mile which proved useful so far as it went. Of the remainder of the field to the west, beyond the limits of Mr. Williams's map, no plans whatever existed. I, therefore, knowing that the coal bearing rocks extended considerably beyond the limits of Mr. Williams's map, applied for authority to employ a Surveyor to make a plan of this part and of one or two other places which were deficient. This I accomplished, and we have traced the coal-field now to its extreme westerly boundary.

Subsequently I visited the field myself, and devoted several weeks to obtaining a knowledge of its general structure.

The examination of the whole field being incomplete, it will be necessary to reserve all minute geological details for a future period. In the present preliminary report, therefore, I shall confine myself to the present state of the field economically, its out-turn, the direction in which the greater quantity of coal may be looked for, &c., and as a consequence, the directions in which lines of communication should be opened up.

I paid a hurried visit to this field in 1851-52, soon ofter my first arrival in the country. At that time there were scarcely half a dozen pits at work in the whole field. Nothing struck me with greater surprise than the almost total neglect of so valuable and important a district. But the scene has totally changed now. Every known locality where coal is, or has been seen, has been worked into. Quarries are seen in full work, where formerly nothing but barrenness existed. And at the present time the great difficulty consists in procuring labor sufficient to meet the increased demands.

At the period of my earlier visit, I endeavored to obtain some trustworthy statistics as to the amount of coal then raised throughout the field, but without success. I have repeated these efforts since at different times, but in vain. And I found that it was only by going from pit to pit, from quarry to quarry, and by obtaining from each the average out-turn, that returns, even approximately trustworthy, could be procured. This has been done during the past season by Mr. W. T. Blanford, by Mr. Wilson, and by myself. When it was possible, the returns, as stated to one, were checked by those stated to, or calculated by, another, and their accuracy thus tested. But it is not pretended that in a first attempt of this kind perfect accuracy has been

attained. To this report I have appended a tabular statement showing the annual out-turn of all the collieries at work in the field, excepting the very few which lie south of the Damooda, and which yield but small returns.

From this return it will appear that the total quantity of coal, which at the present rate of out-turn would be raised in one year, amount to 90,79,000 maunds or nearly 325,000 tons, a very large and steadily increasing out-turn from a single field and an amount of a very valuable product, which fairly claims all possible facilities for its removal.

I will hear explain that this return is calculated on the present yield of the collieries, and does not represent the amount actually raised in the 12 months last past. I am satisfied, however, that it is rather under than over the mark as regards the present out-turn of the field. But to be perfectly certain of not overstating the facts, let us deduct from this amount, say 15 per cent., and there will still remain 77,17,150, say 77 lakhs of maunds.

Of this very large out-turn a very considerable portion is carted away across the country to many of the stations on the extension of the line of Railway towards Rajmahal; much also is still sent down to Calcutta by water in boats on the Damooda; while a considerable amount is consumed locally for the supply of locomotives, &c., &c. One thing is quite certain that the present line of railroad *does not (and cannot at present) carry more than about two-fifths of the whole amount of coal raised.* The total quantity carried by rail during the 12 months of the year 1858 was 33,16,241 maunds.

It is therefore obvious that at the present moment the colliery line does not meet the requirements of the traffic in coal.

No doubt a large amount of this deficiency arises from the simple fact that the rolling stock of the Railway is not yet sufficient for the great demands upon it. Neither engines nor trucks can be given up for this coal trade in sufficient quantity, and the consequent uncertainty of obtaining carriage for coal, prevents proprietors from sending it to the stations. I am aware that this is being remedied as quickly as conveniently can be done, and that there has been a considerable increase in the amount of coal conveyed by rail since the 1st of the present year as compared with the amount carried during the last six months of the past year.

But there is another reason also which must always, under existing circumstances, prevent the full development of the traffic in coal along the present line of rail. It need scarcely be reiterated now that the present terminus of the railroad near Raneegunge, in reality accommodates one group of mines greatly more than any other. It is undoubtedly the case that its facilities of transport are open to all who can reach its sidings, still the fact remains that its terminus is upon the grounds of one company and that that company have carefully so contrived their holdings as to cut off any direct communication with the terminus from most other collieries. Virtually, this gives them an advantage of no little amount. As an instance, the pits at Munglepoor are not more than two miles in a direct line from the station at Ranee-

gunge, but carts conveying coal are compelled to proceed along the trunk road, and then by the Government branch road to Raneegunge, making the distance, over which the coal must be carted, six miles instead of two, *while there is a direct bye-road used by all ordinary carts without interruption.*

I do not wish to be understood as objecting to the right of the Bengal Coal Company or any other company to prevent others from passing across their lands. I only advert to the fact to show that even the collieries in the immediate vicinity of the terminus have a difficulty in obtaining a means of access to it. How much greater, therefore, must be this difficulty for those whose locality is further removed.

I did not find that there were any well-grounded complaints of the changes made, excepting in the case of short distances, such as to Burdwan, &c., the rates for which were represented as very disproportionately high; but this has evidently affected the amount of the coal-carrying trade to a very slight degree.

These causes, to a great extent, account for the apparently anomalous fact that this line of road, expressly constructed as a *colliery branch*, has not yet secured to itself one-half of the total trade in the carriage of coal.

The question may fairly be raised here, how far we are justified in anticipating any great increase in this coal trade in future years? Is not the present demand quite exceptional? Now, to arrive at any fair conclusion on this point, it will be necessary to see what has been the increase up to the present time. In the year before I first saw this coal field (1850) there were conveyed to Calcutta from it 22 lakhs of maunds of coals. There was very little brought to any other market at that time, and neglecting the dust coal, which would not pay for the transport, and was therefore allowed to burn at the pit mouths, we may take this amount, 22 lakhs, as the total amount raised during that year. In 1858-59, as we have shown, the amount will be 75 lakhs, or, in other words, the amount raised is three and a half times as much as nine years since.

Now, this increase has been, independently of the very great demand which the new projects of the Eastern Bengal Railway Company, of the Mutlah Railway Company, of the extended navigation of the Hooghly and Ganges, of the great increase in the application of machinery to manufactures and other appliances of civilization, and of the steady and very large demand which, even after the opening of the line of rail to North-Western Provinces, will exist for its purposes. I cannot, therefore, see the slightest reason to doubt that the present traffic for coal will be enormously increased; and I fancy that if it be estimated as likely to equal eight or ten times the present traffic in a few years to come, the estimate will be a very moderate one.

That there is an abundance of coal in the Damooda field to meet this demand for years to come, has been placed beyond a doubt by our recent examination of the field.

It is at the same time perfectly obvious, I think, that the present facilities for transport cannot by possibility meet this extended demand.

The present means of transport for the coal are the railroad, carts, and the Damooda. I think it needs no argument to prove that there cannot be any very great expansion of the transit by carts ; the tediousness of the transit, the heavy cost, and the narrow limits thereby imposed on the circle accessible from any one place, at once prevent the system being adopted wherever it can be avoided.

The transport by the Damooda is exceedingly precarious and dangerous. The coal must be stored up on the bank of the river for months ready to be shipped at a moment's notice, to take advantage of the sudden floods which sweep down this stream ; and frequent and numerous are the losses of boats during their passage down. These difficulties increase enormously in the higher reaches of the river, rendering it a much more difficult, expensive, and riskful task to discharge boats from the parts of the river near to the Burrakur than near to Raneegunge.

It follows that any really useful extension of the existing facilities of transport must be sought in extending the line of railroad.

This naturally leads to the consideration of the important question relating to which information was originally requested, namely, the proper direction for any proposed extension or branch of the existing line of railroad.

To show at a glance, and without any complication, the positive as well as the present out-turn of the collieries of the field, I append a map on which the localities of all these workings are marked, the amount of coal annually raised being given in maunds underneath the name. A simple inspection of this map will at once show the true direction in which (*so far as the coal is concerned*) any lines of communication should be opened out. There will necessarily be other and very important considerations to be taken into account before a line be fully determined on, such as engineering facilities or difficulties. But still one main point is gained by showing the direction in which a line designed chiefly to accommodate the largest number and the most valuable of the collieries should be laid out.

At the eastern end of the field, to a considerable extent, detached from the other collieries in the district, there exists a group of valuable and productive mines, which stud the banks of the Singarrun stream on either side, and which form a distinct line of productive collieries in themselves. Of those which are on the right bank of the Singarrun, the nearest to the present line of railroad are the pits now being opened at Baboosole, where the coal has been proved but which are not yet working.* Succeeding these to the north are the very productive and extensive mines and quarries of Munglepoor, the property of Messrs.

* The pits marked on the published revenue survey maps of this district have been abandoned. They furnish an admirable instance of the haphazard way in which such works have been, for the most part, undertaken in this field. No coal was known to exist there. There was no reason to suppose that any would be found. No boring even had been made, but an expensive engine-house was erected ; an engine put up and two large pits commenced. After sinking a considerable way, and nothing but sand having been met with, the whole was abandoned and the engine removed ! !

Erskine and Co., (one of the oldest established workings in the field). Passing northerly again to these, succeed the workings of the East India Coal Company at Gopinathpoor and Bansra, the old works of the Bengal Coal Company at Koolustoree (now idle), and then the extensive mines of Taposi or Tupussee, on the property of the East India Coal Company. North of these and close to Chowkeedangah there are also a few open pits, of no great size, in the hands of Natives. All those mentioned are on the west bank of the Singarrun. On the left bank, we have the recently opened colliery of Madulpoor or Hurrispoor, from which a considerable amount of good coal is now being raised. Then the new colliery at Purusseeah not yet at work. Some large open quarries and mines at and near Dussul, and further to the north, the valuable mines of Chowkeedangah, the property of Messrs. Nicol and Sage. These are the most northerly pits worked in this part of the field.

Beyond this, to the north, the middle section of the rocks of the field comes in, and in this division no coal of any value occurs. Continuing in the same direction, and passing to the north of the Adjai River, the thick and massive bed of the Kasta coal is met. But this is separated by a long intervening space, where coal is not known to occur, from Chowkeedangah.

From all the pits and workings on the Singarrun which we have mentioned, there is at the present time a total out-turn equivalent to an annual yield of 23,39,000, (or deducting for any over-statement of amount 15 per cent. as before) say 20 lakhs of maunds per annum, or 240 tons daily (allowing 300 working days). There is, therefore, at the present rate of out-turn, a sufficient amount of coal raised from the mines along this line to fill one train daily, and there can be no doubt that, with increased facilities of transport to market, this amount would be at least doubled.

Of the quantity *now* raised, perhaps about one-half is conveyed by rail, the other half being carted away direct to Soory, Synthea, and other places on the line of the railroad to Rajmahal, where works are progressing. Were greater facilities for transport by rail given, there would certainly be a larger proportion of the whole carried in that way.

The direction obviously indicated for any branch of the railroad to accommodate these collieries is from at or near the Ondal station on the present line, through Baboosole, Munglepoor, Toposi, to Chowkeedangah. There is nothing beyond this to the north at present which would re-pay the cost of a railroad. This distance is about 8 miles only; the ground is peculiarly favorable; there would not be a single heavy work on the whole; the proprietors are all naturally most favorable to the project, and willing to aid and co-operate in every way; there is capital material for ballast and good stone on the line; and altogether the whole could be most economically and rapidly constructed. I am informed by Mr. Turnbull that the estimate is under £4,000 per mile,* and that the whole work could be done in nine months' time from commencement.

* Only requiring a profit of £1,600 a year to pay five per cent.

I feel perfectly satisfied, therefore, that a short branch, leaving the present line at or near to the present station of Ondal, and passing in the direction I have mentioned along the right bank of the Singarrun and nearly parallel with it to Chowkeedangah, would prove a highly profitable investment to the Railway Company; would be a positive and very great boon to the colliery proprietors along that line; (and ought, therefore, to meet with their warm support); and would be at the same time a great public benefit in enabling a much larger supply of coal to be brought to market.

There is also another consideration affecting this branch line, that if at any future time the manufacture of iron be undertaken on any large scale in this neighbourhood, the country immediately to the north and west of Chowkeedangah, including *Bahrool* (reported on at length by Mr. D. Smith, Mineral Viewer in 1857), offers many inducements as a favorable locality for such purposes.

Turning now from this group of collieries to the more westerly part of the coal field and again referring to the map appended hereto, two lines appear to be indicated by the position of the collieries as shown thereon.

For one of these, the leading guide in the physical structure of the district would be the valley of the River Damooda. Passing almost due west from the present termination of the line at Raneegunge, it would proceed between the pits of Raneegunge Colliery and those of Searscle, and thence tending a little to the southward, would take nearly a direct course to the mines near Cheenacoory and onwards to Hatima and the Burrakur River. If carried to the west of that stream, the direction is obviously indicated by the Koodeah Nullah, passing parallel to which the line would reach the coal known to exist at Neershah and still further to the west.

The second line should obviously follow, to a great extent, the general course of the Nooneah Nullah. It would pass westwards from the present terminus, south of Searsole pits; thence south of Jameree in nearly a right line to cross the Nooneah Nullah near to the Trunk Road, whence keeping the left, or southern bank of the Nooneah, it could proceed in nearly a straight line to near Bahra Chuck.

So far there seems to be no question as to its course and no great difficulty in the line. Beyond this part it should probably proceed to the north of Kootie, and thence bend round to the south of Lahlbazar, to reach the bank of the Burrakur with a view to crossing that river about one mile above the point at which the Trunk Road now crosses. To the west of the Burrakur the line, if continued, should pass nearly due west to, or towards, Neershah, and on to near Gopalgunge.

Of these two lines we shall speak in succession. The first passes over very undulating country. It crosses the drainage of the country low down, and would, therefore, have to pass over such streams as occur, where those streams are largest. Besides, it would only tend to accommodate a small number of collieries,* and those collieries situated near to the River Damooda by which at present the coal there

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* The total out-turn of these collieries is 9,00,000.

raised is despatched. If carried across the River Burrakur, it would cross that stream at a very unfavorable portion of its course, involving very considerable expense in construction of the requisite bridge; and so far as the country to the west of that river is concerned, it offers no advantages whatever above the other line more to the north.

The other line, which may be called the *Nooneah line*, would pass over much more favorable ground; the surface is less undulated and broken. Only one stream of any size, the Nooneah itself, requires to be crossed, and very favorable places, where the foundation would be good and solid, can be procured for this. The number and yield of the collieries which would be accommodated by this line are very considerably greater than on the other, and are at present more entirely without any efficient means of transport for their coal; and if the line is to be continued across the Burrakur, the point of crossing is much more favorable than near the junction of that stream with the Damooda.

To the west of the River Burrakur I think there would be very little difference in the advantages offered by either line, in the nature of the ground to be traversed.

There appear to me, however, two distinct points of view from which such an extension as is now proposed of the existing line of railway should be viewed.

So long since as 1852, I had the honor of submitting my deliberate view that a line of railway *must be* at some time or other carried in a more direct line from Calcutta towards the North-West than is afforded by the Rajmahal or Ganges Valley line. In doing so I must at once confess that, in common with every one who had thought of the subject up to that time, I made a most serious mistake in supposing that the passenger traffic would be trifling on Indian lines. I fully admit that the experience of every line open in India has proved exactly the opposite. But I think at the same time that this fact only becomes an additional and very strong argument for the absolute necessity of a more direct line.

I pointed out then, I believe for the first time, the advantages of striking the Ganges Valley at the great trading town of Patna, and showed that the saving in distance between the two lines (a direct one and the Ganges Valley line) would be about 100 miles! I would further add, that the maximum gradient then anticipated on the Ganges Valley line was the impossible one (as since proved) of 1 in 1,000, and I may be permitted to remark that it was to a great extent the admission of such a gradient as the ruling principle which led to the summary rejection of several projects for diminishing the length, and, consequently, the time and expense of construction of the line, such as the More Valley line, &c. I may also add that since then it has been found more expedient to admit a gradient *so high as* 1 *in* 264 on the river line.

In 1852 I indicated, without in the least intending to point out *exactly*, the route for a line which would have connected Patna with Raneegunge. It is highly probable that a better route in the same general direction may be found, but every succeeding year has convinced me more fully and more strongly of the propriety of seeking for and constructing such a line. That the ground is favorable from the

3rd.—That there is a very large and important field of coal to the west of the Burrakur extending beyond the village of Gopalgunge on the Trunk Road, or about ten miles from the banks of the Burrakur, at or near Taldangah; that this field will, when once opened up, demand railroad accommodation, but that in all probability the opening of the lines above spoken of will give abundant accommodation for some years to come, while it is at the same time most likely that questions of further and more distant extension of the railroad will come under consideration. And that this portion, therefore, of the contemplated extension may abide the result of such further consideration without injury to any present demands for extended accommodation.

As soon as the geological maps of this intricate and important district be completed, they will be submitted.

I cannot conclude this report without urging the most serious attention to the terrific drawback to the full development of this most valuable field which exists in the very lawless and disgraceful manner in which some of the larger proprietors in the field, and more especially one firm obtain or seek to obtain their objects by force. If a boundary be disputed, if a roadway be required, the first appeal with these parties is in no case to the courts of law for a calm and unbiassed investigation of facts. The ground in dispute is forcibly taken possession of often with loss of life, and the loser is then permitted to seek his remedy by a process of law.

I had frequently heard of such things. I had myself heard one of the oldest proprietors in the field state, that they had, during the earlier years of their establishment, spent Rs. 1,20,000 solely in fighting for the protection of their undoubted rights, or in retaliating on their opponents. During my recent visit, I was led to calculate that the amount paid for *lattials* by one company was very nearly equal to their expenditure for the general superintendence of their works.

While in that neighbourhood, I heard of more than one affray with loss of life. Shortly before, the agent of one company was stopped on an open roadway and attacked by the bludgeon-men of a rival company; his horse speared, and he escaped only by the speed of the animal he rode. Of the intention to make this attack he had received the warning which he discredited.

Servants returning from the public bazar have been attacked and beaten; carts conveying gram for horses stopped, and their loads spilled about the road (showing that it was no desire of robbery that originated the attack).

It is altogether foreign to my purpose to say who are to blame for such lawless proceedings; but it needs no arguments to prove that while such outrages do take place, it will be simply impossible that this most valuable mineral field can ever receive or attract proper attention while such is the prospect which every new adventurer must hold before him. Where such outrages are permitted to occur, where life is thus insecure, and property unsafe, no man who may not be fully prepared to resort to similar proceedings in self-defence, will venture.

I am compelled by a sense of duty to speak strongly on this point; first, because I feel confident that such could be repressed; and secondly,

because I am perfectly assured that nothing will prove so effective a police arrangement as the existence of the proposed lines of railway, which will give a roadway open to all, which will render each portion of the field more self-dependent and more accessible, and will at once put an end to almost all disputes to right of roadways, privileges of ghats, of waterway, &c., which have hitherto proved so fruitful a source of dispute and contention.

If no other end than this, the establishment of peace and security to property, were gained, I should think the whole sum likely to be devoted to the proposed lines well expended.

Statement of the present yearly out-turn of Coal from the various Collieries of the Raneegunge Coal Field.

I.—Mines on the neighbourhood of Raneegunge.

	Collieries.	Proprietors.	Out-turn in Maunds.
1	Raneegunge ...	Bengal Coal Company ...	19,00,000
2	Searsole ...	Baboo Gobind Pundit ...	16,00,000*
3	Rogonath Chuck ...	Messrs. Erskine & Co. ...	2,50,000
4	Gopinathpoor ...	East India Coal Company	1,00,000
5	Dumoolia ...	Bengal Coal Company ...	4,00,000*
6	Jameree ...	Baboo Gobind Pundit ...	2,00,000*
			Total...44,50,000
	Mines in progress, but from which Coal had not been raised in April 1859.		
7	Neemohah ...	Bengal Coal Company.	
8	Harrabhaugah ...	"	
9	Tupussee ...	"	

II.—Mines on the Singarrun Valley.

	Collieries.	Proprietors.	Out-turn in Maunds.
10	Hurrispoor ...	Bengal Coal Company ...	4,00,000*
11	Munglepoor ...	Messrs. Erskine & Co. ...	8,00,000
12	Jote Jankee ...	Baboo Koylasnath Roy ...	15,000
13	" ...	Baboo Chatternath ...	40,000
14	Tupussee ...	East India Coal Company	4,80,000
15	Dussul Quarry ...	"	14,000
16	Mahomudpoor Ditto ...	Baboo Sugmai Nundy ...	40,000
17	Chowkeedaugah ...	Messrs. Nicol and Sage ...	4,50,000
			Total...22,39,000
	Mines in progress, but from which Coal had not been raised in April 1859.		
18	Baboosole ...	Bengal Coal Company.	
19	Bausrah ...	East India Coal Company.	
20	Purusseah ...	Baboo Koylasnath Roy.	

* Returns only approximate.

III.—Mines on the East Branch of the Nooneah.

	Collieries.	Proprietors.	Out-turn in Maunds.
21	Purihaspoor ...	Bengal Coal Company ...	1,50,000
22	Samsoonderpoor ...	Baboo Khassi ...	1,00,000
23	Churnpoor ...	Mr. Jackson ...	80,000
			Total... 3,30,000

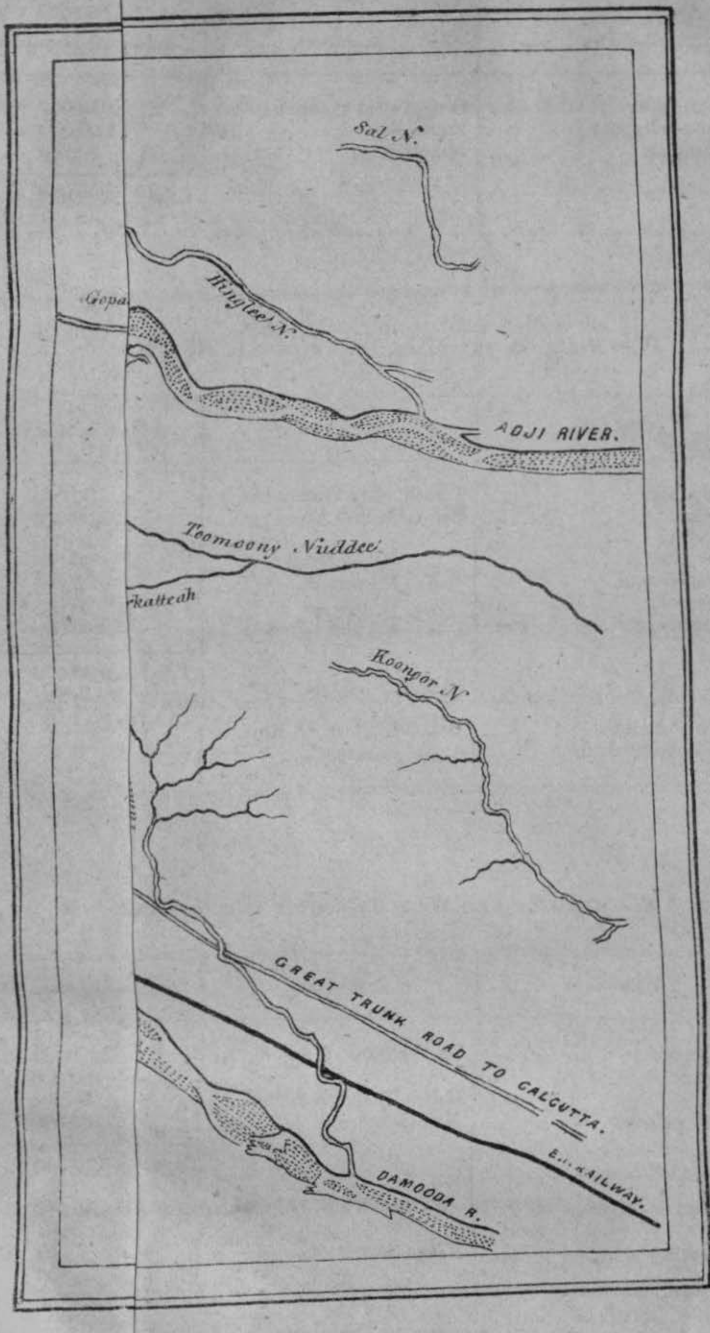
IV.—Mines on the Main Stream of the Nooneah.

	Collieries.	Proprietors.	Out-turn in Maunds.
24	Kulpahari ...	Tarachunder Paul & Co....	80,000
25	Ningah ...	Baboo Gobind Pursad ...	2,00,000*
26	Gooshiri ...	"	50,000
27	Sreepoor ...	" Rahal Dass ...	20,000
28	Kissubgunge ...	" Bussonath ...	5,000*
29	Assensole ...	" Ramanath ...	20,000*
30	Mamanugger ...	" Debhidin Sookul ...	2,00,000
			Total .. 6,20,000
	Mines in progress, but from which Coal had not been raised in April 1859.		
31	Sath Pokuria ...	Baboo Koylasnath Roy.	
32	Pit opposite ditto ...	" Ramanath.	

V.—Mines on the West Branch of the Nooneah.

	Collieries.	Proprietors.	Out-turn in Maunds.
33	Futtipoor ...	Mr. Jackson ...	2,00,000
34	Gurooe ...	"	60,000
35	" ...	Baboo Debhidin Sookul ...	50,000
36	Bahra Chuk ...	Mr. Jackson ...	60,000
			Total... 3,70,000
	Mines in progress, but from which Coal had not been raised in April 1859.		
37	Sitarampoor ...	Ranee Surnomonee ...	

* Returns only approximate.



Sal N.
Hinglee N.
Gopa
ADJI RIVER.
Toomoony Nuddee
rkatteah
Koongor N.
GREAT TRUNK ROAD TO CALCUTTA.
DAMOODA R.
RAILWAY.

VI.—Mines near the junction of the Burrakur and Damooda.

	Collieries.		Proprietors.	Out-turn in Maunds.
38	Cheenacooree	East of Burrakur.	Bengal Coal Company ...	4,00,000
39	Hatinol		Messrs. Erskine & Co. ...	1,00,000
40	Doomucoondah	West of Burrakur.	Bengal Coal Company ...	1,50,000
41	Chamuh			
42	Noorhebad			
				Total... 6,50,000

VII.—Mines not included in the above.

	Collieries.		Proprietors.	Out-turn in Maunds.
43	Lahlbazar, East of Burrakur, North of Grand Trunk Road ...		Messrs. Erskine & Co. ...	1,00,000 2,00,000*
44	Heeracoon	South of Damooda ..	Bengal Coal Company.	
45	Chukbugur			
46	Kasta	North of Adji..	Messrs. Nicol and Sage...	70,000
47	"		East India Coal Company	50,000
				Total... 4,20,000

General Abstract.

			Maunds.
Mines in work ...	37	I. Mines near Raneegunge ...	44,50,000
" in progress ...	9	II. " on Singarrun ...	22,39,000
	—	III. " on Nooneah E. Branch ...	3,30,000
Total ...	46	IV. " on " Main Stream ...	6,20,000
	=	V. " on " W. Branch ...	3,70,000
		VI. " near junction of Damooda and Burrakur	6,50,000
		VII. Other Mines	4,20,000
		Grand Total ...	90,79,000

* Returns only approximate.

APPENDIX IV.

OFFICIAL CORRESPONDENCE REGARDING THE EXISTENCE OF COAL AND IRON IN THE PUNJAB.

From R. H. DAVIES, ESQ., *Secretary to the Government of Punjab, to the Secretary to the Government of India Public Works Department, Calcutta,—Nos.* 373–1819, *dated Lahore,* 5*th August* 1859.

I am directed to enclose in original a letter, and its enclosures, this day addressed by order of the Hon'ble the Lieutenant-Governor to Professor Oldham, of Calcutta, relative to certain researches for coal and iron in the Hills about Murree, which His Honor has recently caused to be instituted. The specimens have been forwarded this day to your address in two separate packets by banghy post.

2. I am to request that after the enclosures have been perused by His Excellency the Viceroy, they may be forwarded, with the specimens, to Professor Oldham for analysis.

3. It is of great importance to have a speedy reply from Professor Oldham, the Committee now being on the spot, and the Lieutenant-Governor trusts there may be no delay in his reporting.

From R. H. DAVIES, ESQ., *Secretary to the Government of Punjab, to* PROFESSOR OLDHAM, *Calcutta,—No.* 1818, *dated Lahore,* 5*th August* 1859.

The Hon'ble the Lieutenant-Governor has recently appointed a Committee for the purpose of examining and reporting on the existence of coal and iron in the Hills about Murree. The Committee have just furnished their first report, a copy of which I have the honor to annex. The specimens have been forwarded in two separate packets to the Secretary to the Government of India Public Works Department, with a request that they may be forwarded to you with this letter.

2. His Honor will be much indebted to you if you will analyze these specimens and communicate the result at the earliest date possible. Should the specimens from the north-east face of Mount Nir prove to be coal, as supposed by the Committee, it will be a great incentive to vigorous exertions. The mountain is on the banks of the Jhelum River, and there is water carriage within a few hundred feet of the locality.

Proceedings of a Committee assembled by order of the Hon'ble SIR ROBERT MONTGOMERY, K. C. B., *Lieutenant-Governor of the Punjab and its Dependencies, to examine and report upon certain deposits, in ranges of mountains around Murree, supposed to be coal.*

PRESIDENT:

MAJOR A. ROBERTSON, *Offg. Supdt. Lahore and Peshawur Road.*

MEMBERS:

CAPTAIN H. C. JOHNSTONE, *Surveyor Derajhat.*

" H. P. BABBAGE, *Assistant Commissioner Murree.*

T. A. S. H. WILSON, ESQ., *Assistant Engineer, Offg. Executive Engineer Goojrat Division, Lahore and Peshawur Road.*

The Committee having assembled pursuant to order at the village of Bugla, about 12 miles from Murree, on Wednesday, the 20th day of July 1859, and having received the attached instructions from the

Secretary to the Punjab Government, occupied from the 20th to the 29th July in visiting various localities where the deposits had been found, and report as follows :—

1st.—The deposits under the village of Bugla, two in number, and two others in the same ravine, but some miles further down, and all within a short distance of the bottom of the ravine, were found to be small isolated irregular masses of a substance which the Committee consider to be lignite; all the specimens, with one exception, were completely dug out. The exception, a small irregular mass in the face of a cliff, was so similar to others dug out that the Committee did not deem it necessary to incur the expense of blasting it.

2nd.—A specimen, similar in all respects to those above referred to, was completely excavated from the side of the ravine between the villages of Bail and Chuckka.

3rd.—Under the villages of Bulannia and Bhun, in ravines, two other specimens were completely dug out; these the Committee also consider lignite.

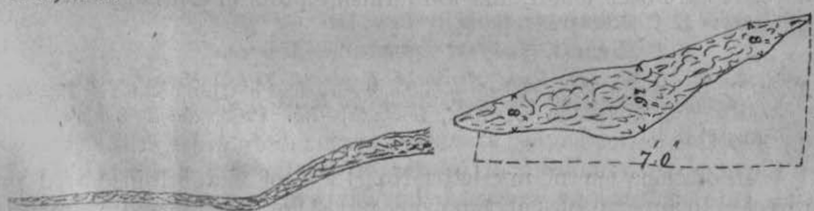
4th.—A very thin vein, not exceeding one inch in thickness, and about 40 or 50 feet long, was examined about a mile to the north-east of the village of Kotlee. It is in the face of a sandstone cliff, and was so insignificant that the Committee did not deem it necessary to incur expense in blasting it out.

5th.—On one of the spurs of Mount Nir, under the village of Thoon, a deposit was found in the face of an isolated rock; it appeared so similar to others dug out that nothing was done with it.

6th.—The examination of the specimens sent into Murree led the Committee to look with most confidence to the deposit on the south-east side of Mount Nir near the village of Kundole. Mount Nir seems to have been the centre of considerable disturbance. The main portion of the mountain is formed of alternate layers of sandstone and clay in nearly horizontal strata, having only a slight dip to W. S. W. A lower range close to it on the south-east has the strata dipping to the north, almost at an angle of 45°. The ranges to the north parallel to Mount Nir, as far as and including the Murree Range, have the strata dipping also to the north at from 30° to 35°, while the mountains to the east across the Jhelum River have the strata dipping only slightly to the east.

On the east face of Mount Nir,* about 800 or 1,000 feet above the level of the River Jhelum, and at no great distance from the river, is situated the deposit above referred to. It is in an irregular vein at the foot of a sandstone cliff, having a blue clay both above and below it. The main portion of the vein is about seven feet long, of an irregular form, 16 inches wide at the centre, and 8 inches at the ends, thus—

* About 20 miles south-east of Murree.



It shows again irregularly to the right and left, but much thinner, and altogether extends as far as can be seen about 30 feet in length. The deposit is mixed with slate, and appears to the Committee to be coal of a fair quality.

No Member of the Committee possesses a sufficient knowledge of geology to pronounce an opinion upon what may be expected from following up the vein, or whether it is most advisable to push the investigation by further search in the line of the vein above it or below it; nor have they the means or manipulatory skill definitely to pronounce upon the real nature of the deposit. The test they have applied, and upon which their opinion as to its being coal of fair quality is based, is distillation, under which it yields gas which burns with a white clear flame, and coal tar; but as far as they could discover, no trace of acetic acid.

On the north-east spur of the mountain, but a short distance from the site of the above deposit, but much higher up, a deposit is reported in the face of the sandstone cliff. The specimen was brought in after the Committee had left. It has the appearance of cannel coal or jet, being hard and polished, and not soiling the hand.

The Committee would recommend that the accompanying specimens of the deposits from Mount Nir, with the above description of the mountain, be sent at once to Professor Oldham at Calcutta, and his opinion of the specimens and advice as to the best means of conducting the search be solicited. Meantime the Committee recommend that a boring be made from above, and about 60 feet back from the face of the cliff, at the foot of which the vein exists, to ascertain whether the vein extends back, and if so, if it increases in thickness. The Committee are also inclined to follow up the search by sinking shafts, as they look for thicker veins being found below, but they hope to be guided in this matter by Professor Oldham's opinion.

7th.—A large vein of black deposit is reported to exist in the bed of the Jhelum River, under the village of Kotlee, at present under water, but laid bare in the cold weather; this should be examined as soon as the river falls.

8th.—Wherever the deposit was found in rock, the rock under was stained red by the wash from the vein. This the Committee believe shows the presence of some of the salts of iron in all these deposits, probably the sulphuret.

The Committee would also add that in the two latter specimens referred to in paragraph 1, what they consider iron pyrites was observed, and in the sandstone close to the vein on the east face of Mount Nir, traces of what they consider mica were discovered.

9th.—The Committee propose proceeding to visit other spots where deposits have been found, and will furnish reports in continuation.

From R. H. Davies, Esq., *Secretary to the Government of Punjab and its Dependencies, to* Professor Oldham, *Calcutta,—No.* 1963, *dated Lahore, 22nd August* 1859.

In continuation of my letter No. 1818 of the 5th instant, I am directed to annex copies of two more reports of the Proceedings of the Committee appointed for ascertaining the existence of coal and iron

in the Hills about Murree. The specimens therein referred to have been forwarded for analysis by bullock train to the address of the Secretary to Government in the Public Works Department, through whom this letter will be forwarded to you.

2. The Hon'ble the Lieutenant-Governor requests that you will be so good as to examine the specimens now sent, and give your opinion on them at as early a date as may be practicable.

Supplementary Proceedings (No. I) of a Committee assembled by order of the Hon'ble Sir Robert Montgomery, K. C. B., *Lieutenant-Governor of the Punjab and its Dependencies, for the purpose of ascertaining the existence of Coal and Iron Mines on the Murree Hills.*

President :

Major A. Robertson, *Offy. Supdt. Lahore and Peshawur Road.*

Members :

Captain H. C. Johnstone, *Derajhat Survey.*
" H. P. Babbage, *Assistant Commissioner Murree.*

The Committee having re-assembled at Derakote Dutoon on Tuesday, the 9th day of August 1859, continued their examinations of various deposits supposed to be coal, until the 14th August, and report the result as follows :—

1st.—The Committee examined a deposit in the bottom of a ravine between Derakote and Chulavera. This was of small extent, and appeared of no value.

2nd.—In the great ravine under Chulavera, the Committee examined two specimens, one about 400 feet up the bank, and the other in the bottom of the ravine. Both specimens were on the face of sandstone strata; these strata run nearly south-east and north-west, and dip to the south-west at about an angle of 75°, and the two specimens were in lines of sandstone only about 200 feet apart, and separated by layers of clay and indurated clay. The upper specimen was not in the form of a vein, but in an irregular hole in the rock, almost at right angles to the line of the strata; the deposit consisted of what appeared to the Committee a branch of a tree in a horizontal position, surrounded by a deposit resembling coal. The branch was broken up in extracting it; but the pieces, together with a specimen of the rock and the surrounding deposit, are herewith sent.

The lower deposit was found in an irregular vein from one inch to two inches thick, running parallel to the strata, but broken and very irregular; in some places, one vein only being visible, and in other parts two and three parallel ones; the whole extent exposed was about 30 feet in length. The deposit was in contact with clay, some of which appears to the Committee to contain iron; specimens of the deposit clay, contiguous rock, &c., &c., accompany.

3rd.—The next deposit was found close to the village of Bandie, a considerable distance up the hill, and was completely dug out; specimens are submitted.

4th.—The last specimen examined was under the village of Cheganah, in the bottom of the ravine, found in exactly the same descrip-

tion of rock as the second and third specimens, the direction of the strata being the same, but almost vertical instead of dipping to the south-west. The deposit was found in an almost square hole about 18 inches on the side and in the line of the strata. Specimens of rock and deposit are submitted. The Committee would explain that all these specimens, as well as two referred to in last report, were found in one, ravine or its branches, raising near the village of Kotlee and running in N. N. E. direction until it joins the River Jhelum, under the village of Cheganah. The ravine is about eighteen or twenty miles long, and seven specimens have been found along it, all with one exception near the bottom.

The specimens examined by the Committee are all either isolated masses, or the veins so meagre, that, in their opinion, there is little inducement to incur expense in boring, or other examination, but they consider Professor Oldham should be consulted on the subject.

The Committee have now completed the examination of all specimens of supposed coal discovered and reported, and they purpose proceeding to-morrow to examine the iron mines at Bukkote, &c.

The Committee are of opinion that specimens (of coal) should be found in the Hills on the Kahoota Tuhseel, and would suggest the offering a reward in that Tuhseel, as also in Huzara.

Supplementary Proceedings (No. II) of a Committee assembled by order of the Hon'ble Sir Robert Montgomery, k. c. b., *Lieutenant-Governor of the Punjab and its Dependencies, for the purpose of ascertaining the existence of Coal and Iron Mines on the Murree Hills.*

President:

Major A. Robertson, *Offg. Supdt. Lahore and Peshawur Road.*

Members:

Captain H. C. Johnstone, *Derajhat Survey.*
" H. P. Babbage, *Assistant Commissioner Murree.*

The Committee occupied from the 15th to 17th in examining the iron deposit at Bukkote. This iron is found in the limestone formation; is in the form of nodules embedded in clay; the clay appears an isolated deposit, not in the form of a vein; and the Committee do not feel themselves qualified to pronounce an opinion as to the supply, but no doubt Professor Oldham will be able to do so from an examination of the specimens accompanying, and the Committee are prepared to furnish any further information he may require.

The Committee obtain some information regarding coal (near Bukkote) and two specimens herewith submitted, one of which much resembles plumbago, but the Committee did not follow up the search at the present time, as it appears no notice has been given to the people in Huzara, and they therefore thought it better to differ further researches until such time as the people have been told that rewards will be given. The Committee have taken upon themselves to offer a reward of five rupees to any individual who points out a seam or vein, not less than twelve feet long and one and half inch thick. They also purpose, with His Honor's sanction, giving smaller rewards for any deposit pointed out.

The Committee will continue their researches as soon as they receive further information.

The Committee submit specimens of quartz found associated with the iron deposit.

Note of Analysis of three specimens of Coal from "the Hills about Murree" received from the Under Secretary to Government of India, 30th August 1859. By J. G. MEDLICOTT, ESQ., *Assistant in charge Geological Survey Office.*

No. 1 Coal.	36	per cent. of volatile matter.
	56	carbon.
	8	ash.
	100	
No. 2	$30\frac{1}{2}$	per cent. of volatile matter.
	$45\frac{1}{2}$	carbon.
	24	ash.
	100	
No. 3	31	per cent. volatile.
	37	carbon.
	32	ash.
	100	

The specimens are numbered 1, 2, and 3, respectively, for convenience; but the original labels were so much rubbed away, and injured by moisture during their transit, as to be almost entirely illegible. No. 3 is that specimen of which a very small quantity was sent in an envelope labelled "Cannel Coal Mount Nir."

2. With respect to Nos. 1 and 2, there ought to be no difficulty in recognizing the specimens to which the analysis refer, from the great quantity of ash in No. 2, but the presence of this greater quantity of ash probably arises from the manner in which the specimens were selected. No. 2 being evidently chosen so as to include, along with what is really coal, a thick layer of shale.

3. This shaly part was of course reduced to powder along with the rest, and an average of the whole taken for analysis; and thus an exaggerated and incorrect idea of the quantity of ash arrived at.

4. If the shaly portions of No. 2 be excluded, the composition of the remainder, or true coal, resembles that of No. 1 as closely as if they had been broken from the same mass.

5. For all practical purposes the accompanying rough analysis will prove sufficient, but a more elaborate one could, if necessary, be made.

6. The volatile matter as above given is slightly excessive, for it includes the water, as also a small portion of the carbon, which latter element will of course appear proportionably less than it ought; the errors, however, due to these sources are very slight.

7. The nature of the volatile gases has not been investigated, nor have the several ingredients of the ash been estimated.

8. No trace of sulphur was detected, and the blocks of coal have carried very well, crumbling very little, though from the torn condition of the wax cloth in which they were wrapt up, they had been evidently much shaken about.

From COLONEL R. BAIRD SMITH, *Offg. Secretary to the Government of India, Public Works Department, to the Secretary to the Government of Punjab,—No.* 6786, *dated Fort William, 27th September* 1859.

With reference to your letters Nos. 373—1819 and 404—1964, dated 5th and 22nd ultimo, I am directed to forward, for the information of His Honor the Lieutenant-Governor, a copy of the report received from the Geological Survey Office on the specimens of coal forwarded with your letter of the 5th August.

2. The report is so encouraging, and the discovery will be of such vast importance if the coal is in workable quantity, that His Excellency the Governor General in Council has resolved on having the localities examined by a competent and scientific geologist, who will be able to furnish the Government with definite and reliable information both on the scientific and economic conditions of the deposits. His Excellency has therefore selected for the duty Mr. H. Medlicott, the Professor of Geology in the Thomason College, a gentleman well qualified for the work, and in whose opinions on such a question His Lordship has every confidence.

3. Mr. Medlicott has been directed to proceed to Murree as early as practicable, and there to await the instructions of the Lieutenant-Governor.

From T. OLDHAM, ESQ., *Superintendent of Geological Survey of India, to the Under Secretary to the Government of India, Public Works Department,—No.* 297, *dated 3rd October* 1859.

Adverting to your letters No. 5995, dated 29th August 1859, and No. 6215, dated 5th September, together with the correspondence forwarded therewith relating to the discovery of coal in the vicinity of Murree, I have now the honor to report—

2. During my absence on duty in Madras, from whence I have only returned a few days, Mr. Medlicott, then in charge of this Office, took immediate steps to comply with the request of the Secretary to the Government of the Punjab, for an analysis of the specimens of coal forwarded, and in his letter No. 294, dated the 21st ultimo, communicated to you the results, adding a few remarks. From that communication, you will have perceived that so far as the *quality* of the minerals forwarded was concerned, they represented good useful fuel, on the whole, better than the average quality of Indian coal.

3. Mr. Medlicott did not enter on any discussion of the probable amount of supply, which would seem to be the most important question

involved. On this point, I regret exceedingly that, after a careful perusal of the Committee's reports, I cannot hold out any favorable hopes whatever. In their statement the Committee very plainly and succinctly give the fact, that in almost every instance where such coal was observed they had *completely dug out the mass*, such as it was. In the only instances in which a vein or bed were seen, these were not more than a few inches in thickness, and very limited in length. From all the circumstances stated, it appears to me obvious that in all the places visited, the Committee have only met with repeated instances of what they themselves very justly suppose to have been the fact in one case, namely, of detached branches or stems of trees or small isolated accumulations of vegetable matter, imbedded in the sandstones. In almost all such cases the bark of the tree is found converted into rich sparkling coal, the stem or woody portion itself being often impregnated with coaly matter also. And I fancy that it is from such layers that the best specimens of coal now forwarded have been obtained.

4. There is not, so far as I can see, anything in the reports of the Committee to warrant the supposition that true *beds* of coal exist in that neighbourhood. There is, therefore, I conceive, nothing at present known to justify the expenditure for shafts, &c., as suggested.

I may mention that precisely similar conditions occur in similar rocks, at the foot of the Sikkim Hills, on the Teesta and Sivok Rivers (see my notes, Journal Asiatic Society Bengal, Vol. XXIII (1854) p. 201). Large fragments of stems and branches of trees are there imbedded in the sandstones, from which coal of very promising quality was obtained, but which proved to be nothing more than isolated masses of no extent.

5. On the other hand, there is nothing in the geological facts of the case to render it impossible that widely extended beds of coal should exist there, and it will be very desirable that the attention of the Natives should be directed to the importance of the enquiry, and the communication of any knowledge on the subject of the occurrence of such coal be stimulated by small rewards. I would beg that I may be kept acquainted with the results from time to time. And should there be any thing to justify a well grounded hope of useful fuel being found, I shall be prepared, under the sanction of the Governor General in Council, to despatch one of my colleagues, or to proceed myself to examine the locality. I am confident that nothing yet reported on would justify the expenditure of time required for such an examination.

6. I would beg the favor of your forwarding this letter to the Secretary to Government of the Punjab at your earliest convenience.

From T. OLDHAM, ESQ., *Superintendent of Geological Survey of India, to the Under Secretary to the Government of India, Public Works Department,— No. 351, dated 19th November* 1859.

I have the honor to acknowledge the receipt of the specimens from Murree of coal, &c., forwarded with your letter No. 7888, dated 15th November 1859.

These specimens have been examined, although I did not think that any of them demanded a chemical analysis; they are in all respects similar to those formerly reported on.

The specimen labelled as "supposed by the Committee to be a portion of a tree" is so. It is a portion of a stem impregnated with silica, and so petrified, with minute strings of coaly matter attached.

From C. A. OLDHAM, ESQ., *in charge of Geological Survey Office, to the Under Secretary to the Government of India, Public Works Department,—No.* 360, *dated 7th December* 1859.

In the absence from Calcutta of the Superintendent of the Geological Survey of India, I am instructed to forward to you the accompanying copy of the report furnished to the Government of the Punjab by H. B. Medlicott, Esq., Geological Survey, on the reported coal of Murree and of Kotlee.

From H. B. MEDLICOTT, ESQ., *Geological Survey of India, to the Secretary to Government of the Punjab, dated Camp Murree, 7th November* 1859.

Owing, as I conjecture, to the great desire of Government, that coal should be found within British territory, what must be considered as the real business of my hurried deputation to the Punjab was not put into my hands for some time after my arrival at Murree. For the first twelve days I was engaged in visiting the localities examined by the Committee appointed by His Honor the Lieutenant-Governor, as well as several other places reported by the Natives since this Committee ceased to act. All these localities are in the Hills of the Rawul Pindee district between the meridian of Murree and the River Jhelum. My researches here proving altogether unpromising, I asked to be shown the report by Mr. Calvert, an Assistant Engineer on the Punjab Railway, on a place in the Cashmere territory not far from the Jhelum, in which report I was told Mr. Calvert asserted the existence of regular seams of good coal. From this report and the file of papers connected with it, I perceived at once that the coal in Jummoo, and the rocks with which it is associated, are entirely different in character from what I had seen in the hills east of Murree. Had I seen this report in the first instance, I should have been satisfied by a much more cursory examination of the Murree rocks, but thinking the conditions of all were alike, I wished, in compliance with Mr. Oldham's instructions, to leave no place unseen. With the permission of Government I therefore proceeded at once to examine the coal deposit near Kotlee in Jummoo. The discovery of coal and the statements that have been published of its abundance in these hills, originated from Mr. Calvert's report. I may then preface my account by a concise relation of the circumstances connected with this discovery. Mr. Brunton, Chief Engineer of the Punjab Railway, accompanied by Major Medley and Mr. Calvert, went to Jummoo, in May or June 1859, for the purpose of enquiring into the possibility of procuring coal in the Cashmere territory. The Maharajah so far afforded them every encouragement; among a number of samples collected by his orders for their inspection, one was recognised as good coal, the others were lignite. The examin-

ation of one locality of this lignite at Aknore on the Chenab was sufficient to satisfy Mr. Brunton of the uselessness of further enquiry respecting it: it occurs in very limited patches imbedded in massive sandstone, and is, no doubt, similar to what I have seen in the Murree Hills. Mr. Calvert was deputed by Mr. Brunton to examine the locality from which the one good specimen was procured near Kotlee on the River Poonch, a tributary of the Jhelum. I need not repeat the details of Mr. Calvert's description; it was such as to satisfy Mr. Brunton and Major Greathed of the quality and abundance of the coal, so much so that the latter officer recommended that no further survey or enquiry should be made regarding it until an exchange of territory or some other arrangement for the extraction of the coal could be agreed upon with the Maharajah, lest His Highness should become unreasonable in his demands.

Before discussing the coal formation of Kotlee, I wish to explain the case of the Murree Hills, and in the hope of satisfying those who are not familiar with such subjects, yet are unwilling to relinquish the hopes that have been raised, I would very briefly state the few simple facts upon which my opinion is founded. First, respecting the chemical or mineralogical question—the *quality*. The fossil substances used as fuel, and most of which are known by the generic name of "coal," present every shade of composition, from that of wood to that of charcoal, which is approximately pure carbon: the process is one of carbonization, or more properly the escape and modification of the volatile elements of the vegetable substance; the varieties thus presented are known as "peat," "lignite," "common bituminous coal," and "stone-coal" or "anthracite;" it is more or less arbitrary at what points of the scale these names are severally applicable; for lignite and coal proper, it is usual to draw the line between the coals that do, and those that do not yield a hard cohesive coke, and it has been found that this property of coking does not exist, or but very imperfectly exists, when the volatile ingredients exceed about 25 per cent., or more generally the heating quality of coal is in proportion to the degree of carbonization. As an attendant fact, in lignite the vegetable structure is still more or less visible. Lignites, however, form a valuable fuel, when better coal cannot be procured. The geological facts affecting the *quantity* are equally simple. Vegetable substances become fossil (buried) in two ways, by accumulation in the place of their growth, and the covering over of such accumulations by sedimentary matter consequent upon the slow changes of level of the earth's surface; or else, vegetable substances become shifted and deposited with other sedimentary matter. The most regular and continuous deposits of coal are proved to have been formed in the former manner. The facts by which a geologist is guided in a search for coal are *directly* by the nature of the rocks, and the presence in them of vegetable impressions; and *indirectly* by noting a series of rocks in which coal is known to occur in one locality, and by its position in that series he can infer the probable or possible presence of coal in the same group of strata in other localities; moreover, he is enabled to follow out any particular bed by studying the amount and direction of the dislocations to which the series have been subject since its formation.

The Murree coal is *lignite*; a good specimen of it analyzed in the laboratory of the Geological Survey of India gave 36 per cent. of volatile matter; in all the specimens the woody fibre is recognizable. I have examined 18 localities, widely scattered through a considerable range of hills, and they all present the same features.

The coal in each consists of the stems and roots of trees imbedded in the thick beds of soft sand-stone of the lower Siwalik formation, or the middle tertiary period of geologists. When the stem has been crushed, the whole 2 to 3 inches thick is lignite; in other cases, the core is mostly silicified (petrified) wood, the bark alone being pure lignite. I did not see any place where half a maund of the substance could be extracted.

It is certainly not *impossible* that at some place in the group, a sufficient accumulation of such materials may have been formed to make it worth working; but to *exhaust* this possibility would be the work of years; the specimens are not confined to any definite position in the formation, but scattered through a great thickness of strata, so that it would be almost a blind search through the whole. For such a search no method could be so good as that of offering a high reward among the inhabitants, whose daily occupations make them acquainted with every portion of the ground, for the discovery of a useful quantity of coal. As for boring or trenching it would simply be incurring expense on the strength of the barest possibility. For this area alone we might, I think, rest upon the *probability* afforded by the uniformly unpromising character of so many widely distributed localities, but this judgment is much confirmed by the extensive experience of these same rocks throughout the length of British Himalayas, where attention has been turned to the point, and with the same result. I could show many places in the lower Siwalik rocks, between the Sutlej and Nepal, where precisely similar nests of lignite can be seen.

I now come to the Kotlee coal. Captain Babbage and I had some trouble in finding the localities mentioned in Mr. Calvert's report, owing to an unaccountable mistake made by that gentleman in his sketch map in which the ravine of the Hills with Dundela and Mohara is placed on the west instead of on the east of the Poonch, the main river flowing past Kotlee. Arrived at Dundela, however, we had no difficulty in recognizing the main features expressed in the drawings. In examining this case, I wish, as far as possible, to accept Mr. Calvert's data; there are some few spots marked on his plan as anthracite, and which I could not discover on the ground, but this hardly affects the general question.

The rocks in the immediate vicinity of Dundela are thin carbonaceous shales and grits, with earthy ferruginous limestones; among them is "the bed or seam of coal or anthracite, varying in thickness from one inch to nearly two feet, undulating in chambers or bunches, more than in a continuous even seam." This is Mr. Calvert's description of the spot he selected, from which to take his samples, and it may serve as a *favorable type* of all that is actually visible. Now, as I remarked above, our *à priori* knowledge or direct observation (short of actually seeing good beds of coal) *can be* but very vague; the rocks enumerated are no doubt such as are frequently associated with coal, but

it were contrary to all experience to establish a general rule to that effect. There is no kind of *necessary* connection between the phenomena; and numerous instances are recorded of such rocks being extensively carbonaceous, as in this case, without proving of any value. Upon these facts alone, therefore, I am convinced that no geologist could confirm Mr. Calvert's conclusion "that a further exploration must result in the discovery of good beds of coal." Among unknown rocks these facts would certainly suggest a further exploration of the surface, but without such a search resulting in some thing more positive, I should consider any mining operations as proposed by Mr. Calvert to be an unwarranted expenditure of money. But it may be that Mr. Calvert bases his opinion upon the *indirect* evidence, which is, as I said, of great importance. He speaks of the red rocks between Kotlee and Dundela as "new red sand-stone," and of the rocks in which the coal occurs, "as carboniferous strata" and mountain lime-stone. If this be his reasoning, I can only say that his facts are incorrect, and his inference unsound. The very strata he describes are thickly strewn with fossils *characteristic of the nummulitic formation*, which is of the lower tertiary period, and do not belong to a Palœozoic or Mesozoic group, as he assumes; but even if these rocks were of the carboniferous period, it were very rash, at such a distance from any known coal measures of that age, to speculate upon their yielding coal. In point of fact indirect evidence is entirely on the other side. From a close comparison of these rocks, with the descriptions given in Dr. Fleming's report on the Salt Range (published in Vol. 22 for 1853 of the Journal A. S., Bengal) I have no doubt that these coal measures are the same as what is there (p. 340) described as "lignite or Salt Range coal." I saw no indications to make me think the measure had been more favorably developed here than there; the resemblance is borne out even in some minute particulars. Dr. Flemming's account is very circumstantial; sufficiently so, I should think, to settle the general question of value. Throughout a length of 130 miles the conditions are uniform, one or two irregular discontinuous seams of coal in carbonaceous alum shales. He gives some instances of attempts to work it, and his report would be a most useful aid to any one undertaking further experiments. What was at first but a want of positive evidence in favor of useful beds of coal at Dundela, thus becomes a case of decided probability against it. On every point the comparison is equally against any experiment at Dundela. Even if Salt Range coal were of established value, the geological conditions at Dundela are such as would make the extraction of it very uncertain; these rocks are only brought to the surface there along a very narrow line of elevation; the softer strata are so crushed up that the run of any individual bed could not be depended on for ten yards at a time. Geographically, Dundela is more inaccessible than any part of the Salt Range, and it is, moreover, in independent territory.

In respect of composition, it is not improbable that in this place, it may have attained a higher degree of carbonization than in the Salt Range, but mechanically it seems to have suffered proportionably; it is in a very fragmentary state. I have not delayed my report until I could, on my return to Roorkee, make a proper analysis of the coal, but I have forwarded two specimens to Calcutta for this purpose.

In fine, it is my unhesitating opinion *that the rocks at Dundela give no prospect of a useful supply of coal.*

As regards iron, I did not see anything at Dundela that deserves to be called an ore: that which the Natives work very near at Moharee is very poor compared to most Indian ores.

It is a concretionary hæmatite (red oxide) but very imperfectly separated from the clays both locally and in the mass, which is irregular in size and direction; being apparently consequent upon the contortion and modification of the carbonaceous and ferruginous shales; its occurrence is very uncertain, much of what the Natives work being found in isolated patches in the hard lime-stone.

It is much to be regretted that the expectations of Government and of the public should have been so needlessly excited: and it is equally to be wondered at, that this could have been effected by such a document as Mr. Calvert's report, a single perusal of which could not fail to suggest grave doubts to any one who was competent to give an opinion in the matter.

I think it probable that localities similar to Dundela may be found in our own territory as I have noticed that the nummulitic rocks come to the surface again along a line west of Murree.

I will investigate this further before I leave the Hills.

Additional report by H. B. Medlicott, Esq.

After my return to Murree from the Jummoo territory, there were still two places, Bukkote and Shah Durrah, reported by the Natives as "coal localities," and that I had not seen. From their position I thought that both might be representatives of what I had seen at Dundela: sample from Shah Durrah confirmed this opinion; the Bukkote locality did not prove as I expected; it is, like all the previous cases in the Murree district, a broken thread of lignite in massive soft sand-stone.

At Shah Durrah, the section is very like that at Dundela. Soft carbonaceous shales cropping out along the base of a lime-stone ridge, and between this and a band of red sand-stones and clays. I did not succeed in getting a sound specimen of the coal, even by digging into the bank; the man who had procured the sample said that the place had since then been set on fire, and, indeed, it had all the appearance of having undergone slow combustion; there was much sulphureous efflorescence about the surface. The villagers stated that small quantities of sulphur had formerly been extracted at this spot. This fact is a further point of identification with the beds already described in the Salt Range; in parts of the Salt Range, sulphur is obtained from the same set of beds as the lignite. Although the actual show of coal at the surface is not so great at Shah Durrah as at Dundela, I would have just as little confidence of obtaining a supply from one place as from the other. The question is then brought back to the Salt Range, where it has already been so often discussed.

In compliance with instructions from Lahore, I accompanied Mr. Brunton to see the old coal diggings at the base of the hills near the village of Seilah; as no satisfactory opinion could be formed from the inspection of a single locality, I spent some days, after Mr. Brunton's return to Lahore, in examining the rocks at other places. I trust that the following conclusions may be depended on as far as facts are required. I need not add to those published in Dr. Fleming's report; it would be easy of course to lengthen the list of places where the coal shales come to the surface, but this would be nothing to the purpose. Dr. Fleming has, if any thing, given too favorable an opinion.

The first question commonly suggested is, may we not expect more by boring or shaft sinking? In respect of the *quantity* to be found, I think this admits of a most unequivocal negative answer, as is very easily understood by the following considerations: The complicated disturbance and subsequent excavation to which these rocks have been subjected were such as to expose, repeatedly, and in every direction, the entire series of strata; now, let it be recollected that coal occurs in beds, not in lodes or veins, and that therefore, every part of these now exposed surfaces, the coal bed among the rest, was once as deeply buried as is at present its continuation into the heart of the range; thus, by boring we should only take one additional section of the series, of which we have already such a great number, naturally exposed to day-light. Without a single exception, these natural sections are unpromising; they show that the coal, though occurring with but little interruption over a very large area, is nowhere of sufficient thickness, or sufficiently constant at a moderate thickness, to give a certainty of an abundant supply.

With the intention of testing its *quality*, I should be equally against going to any direct expense. I believe that the depth of 20 or 30 feet from the outcrop would give a fair sample of what might be expected all through; and the Native mine we visited extended to a much greater depth from the surface.

There still remains the question as to whether this coal, such as it is, had not better be worked methodically, than left to the crooked devices of the Natives. The answer to this had better be postponed. The economy of systematic works would not be felt for a long time after commencing operations. Such a poor seam as this might never repay much outlay in working it; besides, it still remains to be seen if the stuff is workable at any price. I have no doubt that the Natives, if left to themselves, would turn out a large quantity of coal at a cheaper rate than under European superintendence, and it is in this way that I would suggest the experiment to be made: indeed, this is what Mr. Brunton at once determined upon doing when he had seen the mine near Seilah. With proper precautions, I think this course will give the means of deciding whether any thing more can be done or is worth doing. Mr. Brunton told me that a Native had offered to deliver the coal at Mooltan for eight annas a maund; looking at it first as an experiment, I would not be inclined to drive a bargain; a good price would be a principal means of procuring the best that is

to be had; the chief difficulty will be to free the coal from the shale with which it is associated, and into which it graduates; if the price is low, no trouble will be taken to effect this, and the first object of the trial might thus be frustrated.

Before any experiment at regular mining is undertaken, should such hereafter prove advisable, it were most desirable in the first instance to have a detailed geological examination and map made of the entire area. This would require some considerable time; and I do not think that the Geological Survey of India is prepared to undertake it during this season. But I beg respectfully to warn the Government of entrusting such an experiment to a man whose only qualification may be a familiarity with the use of the pick, or experience in the trade of shaft sinking. I have so often in India seen mistakes of this kind made that I think it my duty, as a servant of Government, to give a caution when I have an opportunity.

In the foregoing report, I have throughout endeavored to make my facts and reasons intelligible to those not familiar with such subjects, believing that this was expected from me; it would have been easy to express my opinion in as many lines as I have taken pages.

Having now, in a manner, completed the several direct commissions on which I was deputed to the Punjab, I return to the work I was previously engaged in.

From C. A. OLDHAM, ESQ., *Assistant in charge Geological Survey Office, to the Under Secretary to the Government of India Public Works Department,—No.* 362, *dated* 19*th December* 1859.

In the absence from Calcutta of the Superintendent of the Geological Survey, I am instructed to forward to you the annexed memorandum of the analysis of two additional specimens of coal received from H. B. Medlicott, Esq. The general character of the coal is that of a hard anthracite.

Analysis of two specimens of Coal from Kotlee, Punjab.

No. 1.			No. 2.		
Carbon ...	90 5	per cent.	Carbon ...	90	per cent.
Volatile matter	4 0	,,	Volatile ...	6	,,
Ash ...	5 5	,,	Ash ...	4	,,

APPENDIX V.

Memorandum on the results of a cursory examination of the Salt Range, and parts of the districts of Bunnoo and Kohat, with a special view to the mineral resources of those districts. By T. OLDHAM, ESQ., *Superintendent Geological Survey of India, dated* 30*th April* 1864.

At the commencement of the present year (1864), I received from Mr. T. Login, then Executive Engineer in charge of the salt mines and other works in the Salt-Range, several communications, bringing

to my notice some interesting facts regarding the present state of these mines, and also earnestly directing my attention to the fact that coal had been found in that portion of the Salt-Range in which he was more immediately engaged at many points, and in considerable quantity. Mr. Login expressed an eager desire that the whole area should be carefully examined. In reply I was happy to furnish Mr. Login with the results of analyses of the specimens he had forwarded, and with my own opinion as to the value of this fuel. I also stated to him that arrangements had been nearly completed to enable the Geological Survey to take up the examination of the Salt-Range in detail during the cold season of 1864-65, before which time I hoped that the maps of that portion of the country which had now been for some years in the hands of the engraver in England would be completed. I had long been anxious to take up the district, from a conviction that it would not only prove of great interest (and possibly also of great economic value), but also that it would prove the key to the structure of many parts of North-Western India, where there did not exist the same facilities for unravelling the relations of the rocks. But as no maps were available, on which to record the observations of the geologist, I thought it wiser to defer this work for a time until it could be properly done. And it did not appear to me that there was anything in the facts mentioned by Mr. Login, which was either so novel or so important as to call for a hasty visit.

Subsequently, while engaged in the geological examination of a portion of Behar, in the early part of February, I was desired by His Excellency the Governor General to comply with the earnest request of the Hon'ble the Lieutenant Governor of the Punjab that these coal beds might be examined and reported on at once.

Delaying only the few hours necessary to break up my camp, and to procure the necessary maps, &c., I proceeded at once to Lahore. I found there that, by the kindness of the Lieutenant Governor, excellent arrangements had been made for my getting on at once to the Salt-Range where His Honor then was in camp; and I had the pleasure of Colonel Maclagan's company for this part of the route. I joined the Lieutenant Governor at Baghanwalla on the 1st March, and for some time I had the advantage of moving about with his camp. Subsequently I separated, and proceeded steadily along the entire Salt-Range to the westward, visiting every known locality where coal, or anything like it, had been noticed. At Kalabagh, I crossed the Indus, and pushed on to the west some distance into the Bunnoo district, to visit some places where coal had been reported at the foot of the Chichali and Lowaghur Hills. Thence turning back, I marched through the Chichali Pass, and right across the Kohat district to Peshawur, making such detours as were necessary here and there.

To the several District Officers I am very greatly indebted for their active and most friendly aid, as well as for their valued and hearty personal kindness. His Honor the Lieutenant Governor had been good enough to communicate my arrival to them, and without their assistance, I should have been unable to accomplish the task I had undertaken.

Arriving thus late in the year, it was at once clear that no detailed geological examination of the Range was practicable within the remainder of the working season. I therefore determined to confine myself to a careful examination only of those spots where coal had been seen. From the fact too, that the Natives had all been stimulated to a careful search for any such locality, I knew that there was very little likelihood of my finding any place which they had not already known of, and if I had devoted the necessary time to such detail in any one place, it would have been impossible to have visited many of the other localities before the hot weather had driven me from the field.

Premising thus far, I shall not feel it necessary to enter here into any detailed discussion of geölogical points; many of which, and of the highest interest and importance, have arisen during my visit, but shall confine myself to a simple detail of the localities I visited, and of the facts noticed at each.

This so-called Salt-Range coal has however given rise to much and very irrelevant discussion, and it may be desirable, therefore, to offer a few general remarks before entering on any detail.

It has in the first place been freely stated that the fact of the occurrence of this mineral fuel was discovered within the last few months, or if this were not altogether a new discovery, that new localities where the coal occurred under far more favorable conditions than had been noticed elsewhere, had recently been brought to light. This is altogether a mistake. The so-called coals or lignites of the Salt-Range were noticed in some detail (besides casual notices by others), so long since as 1843, by Dr. Wm. Jameson, now Superintendent of the Botanical Gardens at Saharunpore.* This was many years before the country had passed under British rule. More recently Dr. Fleming, in his earlier sketch of the Salt-Range, its coal and other minerals, published in the Journal of the Asiatic Society of Bengal for November 1848, and in his more detailed report in 1853,† noticed this lignite at length, and gave a list of many localities where it had been examined either by himself or by his able colleagues, Mr. W. Purdon and Mr. W. Theobald. Mr. Theobald himself subsequently (1854) noticed these deposits of coal.‡

Recently the Natives of the hill sides have been encouraged to give more careful search for such beds, and have been stimulated by the prospect of rewards to bring to notice the occurrence of any such coal wherever they might see it. And in consequence of this, a few localities, chiefly in out-of-the-way, and difficultly accessible, places have been made known which had not previously been noticed.

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* Journal Asiatic Society, Bengal, 1843, p. 183.

† Journal Asiatic Society, Bengal, 1853, p. 230, &c. This valuable report reflects very high credit on Dr. Fleming and his colleagues. The map, compiled from original survey by Mr. Purdon, is an excellent guide, although too small to admit of much detail. I am obliged to differ from Dr. Fleming on some important geological points, but so far as the coal is concerned his remarks are excellent. And I have arrived at very similar conclusions after examination of these deposits.

‡ Journal Asiatic Society, Bengal, 1854, p. 651, &c.

Without a single exception I may state that these localities are not of the slightest value as sources of fuel. And all those places where 'coal' is now known to exist, and where there appears to be the least chance of such 'coal' being obtained in any quantity, have been known for the last ten years, if not more. It is, therefore, a misapplication of terms to speak of any recent discoveries either by myself or others.

The increased attention recently directed to these deposits was simply one of those cases of every-day occurrence in this country, where an active and zealous officer coming newly to the district and unacquainted with what had previously been done, seeing these deposits, most properly and most naturally brought them at once to the notice of others, and thus attracted attention to the matter. Similar results must always be the case with regard to such mineral wealth so long as the country has not been carefully examined and mapped geologically; and it most strongly and forcibly illustrates the necessity for such careful examination and record at the earliest possible date. Such maps and records would at least have the high value of preventing any waste of money and time without sufficient consideration. The present is not by any means the only case I could refer to. In reality, in a country of the vast extent of area which India presents, and regarding the structure and mineral resources of which so little has been hitherto known, the value of such geological information will, in by far the majority of cases, be the quasi-negative one of preventing useless expenditure in misguided directions (and this it has done in many important cases), rather than encouraging exertion in the few instances where such is likely to be properly rewarded.

There have then in the Salt-Range no new *discoveries* of coal worth anything within the last few years.

Much has also been written and said, and much argument has been expended, in discussing the supposed differences between lignite and coal; and much that is erroneous in principle, and erroneous in fact, has been urged on either side. In a practical enquiry of this kind I think such attempts at minute distinctions in a mineral so varied and so varying in character as coals and lignites are, and which pass by imperceptible gradations one into the other, entirely out of place, and without any useful result. Provided a good useful mineral fuel be obtained, it matters little practically whether the streak left by scratching this mineral with a knife be brown or be black. The *primary* question is not whether the fuel be equal in quality to other fuels, or whether it contain a higher or lower percentage of ash, or simply whether it be better or worse than other fuels. These questions of comparative or relative value are all of unquestionable importance, but the first and main point to be established is, whether it be a fact that the fuel exist or not, and in what quantity. And this fact in no way whatever depends upon the mineralogical question of whether the fuel be a lignite or a coal, whether it be of tertiary or secondary or other geological age.

Much of the geological reasoning which has been put forward has been based upon the state of geological information of quarter of a century since, and in some cases, even on an imperfect conception of that. The long since exploded idea that useful mineral fuel could only be obtained from rocks belonging to one fixed geological horizon has been boldly appealed to, and most confident assertions have been based upon this. Even the most delusive hopes have been held out to induce further search for coal in these districts among rocks which occurred nearly on this geological horizon—hopes which half an hour's inspection of the rocks on the ground would have shown to be utterly fallacious.

The production of coal, or other mineral fuel of the general character of coal varying slightly in composition, is simply the result of certain physical conditions acting on accumulated masses of vegetable matter, and producing certain chemical changes and decompositions in that vegetable matter. And there is not the slightest ground for supposing that these conditions may not have existed, and have not existed in different places, at very different periods (geological). In truth, we know that this has been the case, and the facts ascertained regarding the geological history of one country cannot be admitted as applicable to the succession of events in another and perhaps distant land. Each must be worked out for itself.

It may be perfectly true that all the useful deposits of coal in Northern Europe belong to one long-continued but connected period in geological history. This fact has, for that portion of the earth's surface, been established by such careful and wide-spread induction that it may be admitted as a law for that area. But it would be erroneous to a degree to attempt to apply the same law to other countries without the same careful investigation of facts previously. And very probably the result of this investigation would be to show the inapplicability of the law. A single instance may suffice to show this. If the reasoning I have alluded to were admitted, it would lead to the conclusion that no workable or useful coal had yet been found in India : a conclusion to which I fancy the wealthy coal proprietors in the Raneegunge and other districts would give a very curt reply. Yet it is tolerably certain, that these deposits do not belong exactly to the same geological period or horizon as do the English coal measures.

I reject, therefore, altogether the reasonings which have been so eargerly put forward as geological, that if this fuel in the Salt-Range be of the geological age to which it has been referred (and I believe correctly referred), it must *therefore* be useless ; or if not useless, that it must occur in such small and irregularly developed quantities that it will be unprofitable to work. Such reasonings are not based on any sound geological considerations, and represent a state of geological enquiry from which the science has long since emerged. Granting that these beds in the Salt-Range are of tertiary age (geologically speaking), this fact, taken alone, gives no good ground for supposing that the 'coal' should be bad in itself, should be limited in quantity, or should be irregular in its development. And yet it may be quite true that such is in reality the case. Still we have not yet accumulated sufficient facts to base upon them a law of induction that it will be so.

We have not yet sufficient knowledge in detail of the peculiarities of Indian rock-formations, nor has our information on these points been sufficiently sifted and arranged to enable us to draw from the few facts which we have been accumulated conclusions so trustworthy that they will be applicable with any certainty to different parts of the country. An excellent instance of this might be found in this very coal of the Salt-Range. It undoubtedly belongs to the great nummulitic period of geologists, and *in this range*, it also undoubtedly occurs only on one fixed and well-defined horizon in that great period. Examination has recently proved that the so-called coal at Lynah in Scinde, occurs at the same horizon, and is accompanied by beds altogether similar in character. It is in fact probable that an interrupted, but, on the whole, a continuous and actual connexion will hereafter be proved to exist between the rocks in the Salt-Range and those extending through Scinde to the sea near Kurrachee.* And when this is the case, it is perfectly justifiable to reason from the character of the deposits in one place to its probable character in another. But there are in India other localities where coals occur, of the same general period geologically, and yet very widely separated in time of production as well as in space. This nummulitic series is of vast thickness, it may be divided into at least three well marked groups, all characterized by distinct forms of life, and each representing a vast lapse of time in its formation. Some of these nummulitic coals occur, as in the Salt-Range, at the very base of this great series, others at the very top (if not of a more recent date). They are accompanied by other deposits of a totally different character, and have altogether been accumulated under totally different conditions. To base, therefore, any reasoning regarding these beds on the single fact (even if this were established beyond a doubt) that they belonged to the same general epoch would be fallacious. And, until these variations are known in some greater detail than now, it will be quite unsafe to reason from the single fact of coincidence or supposed coincidence in geological age to the very complex conclusion of a similarity in the resulting deposits.

Every such case of the occurrence of beds of mineral fuel, especially in a new country and widely separated from other localities, the geological history of which is known, must be determined from an investigation of the facts of that case itself, and not from any general reasoning supposed to be applicable to it by persons who have never seen the place.

I think it right to put forward these views clearly, because I have seen very positive statements to the opposite effect set forth in a very authoritative way, which statements assumed to be based upon geological reasonings of facts. I can only express my own entire dissent from such, and my belief that they have arisen from a mistaken conception of the facts, and an imperfect and unsatisfactory induction from those facts.

It was with such views that I did not admit that the previous investigations into the geology of the Salt-Range had been sufficiently detailed to determine whether such fuel could be worked with profit or

* The 'coal' found in small quantity near Dera Ghazee Khan and in some other places Trans-Indus tends to show this continuity of deposits.

not, although I quite admitted that the geological age of this had been approximately determined.

I shall now briefly note, in succession, the several localities I visited; and I shall take these in the order in which they would be met in proceeding from the eastern end of the Range near Jelalpoor on the Jhelum to Kalabagh on the Indus. I shall confine myself to the very shortest account of the facts in each case, and offer any general remarks afterwards.

1. BAGHANWALLA.—Baghanwalla is a village about seventeen miles from Pind Dadun Khan, and about eight miles from Jelalpoor. It is situated close under the southern scarp of the Salt-Range, on the banks of a small stream of fresh water, which here issues from a gorge in the hills. Passing up this gorge and over a succession of red sandstones and of limestone for about two miles and a half, the watershed is reached, and the pathway then descends towards the north—(this watershed here being well to the south of the highest part of the ridge), the drainage here being carried out through a deep and narrow gorge which cuts through the massive beds of the limestone (nummulitic), and then winds through the deeply scarped masses of the newer tertiary sandstones. The coal is seen crossing the gorge at a distance of about three miles from Baghanwalla village to the north-east. At present the road to it is a mere mountain path, passing for the greater part of the way along the beds of the small streams, which were for the most part dry when I visited the place. It is capable of being much improved, and possibly a better road could be found from the coal out northwards, so as to reach the Jhelum River by the valley of the Boonah (or Bhoonar) Nullah.

The coal itself and its associated beds all dip here to the north at a high angle (63°), and the gorge through which the drainage passes has been cut back, just at this point, along the line of the centre of a sharp curve or bend in the strata. To the west of this line the limestone and underlying coal dip at 58° to the north-west, the strike being as nearly as possible south-west; while to the east the same beds strike to the west-north-west and dip at 63° to the north. With the exception of this very marked bend, the beds hold steadily enough to the east of the little water-course for half a mile nearly, the outcrop being only broken into by the excessive denudation to which all the rocks have been subject. To the west also the 'coal' holds on with considerable steadiness, and may be traced winding in and out of every gully and ravine on the hill side for about a mile and a half, when it dies out.

Where crossed by the little water-course, the bed of 'coal' is 3 feet 6 inches thick, with slight irregularities. It is irregular also in its jointings, and is flaky. It has all the appearance of having been much squeezed and crushed. And it is here, I think, thicker than at either side it will be found to be, the softer bed of coaly matter having yielded more freely to the forces of compression, and been squeezed into the larger spaces left by the bending of the less yielding and less flexible beds of solid limestone when they were curved. The solid limestone above the 'coal' is here not more than 75 to 80 feet thick, a fact of peculiar interest, when this is compared with the enormous development of the same rock as we pass westwards along the Range. Below

the limestone also, and between it and the red sandstones of the lower rocks, there is not here more than a thickness of some 20 feet of beds in all.

The 'coal' is greatly jointed and cracked, and produces, therefore, a large amount of small coal in cutting. When exposed also to the atmosphere itself, the larger blocks which are taken out rapidly disintegrate and fall to pieces. Crystals and flakes of gypsum are common on the fissures of the 'coal,' and iron-pyrites is abundant. The decomposition of this on exposure gives rise to a spontaneous ignition of the 'coal,' and much care must be taken if this coal (or indeed any of the Salt-Range coal) be worked to keep the galleries quite clear of dust and small-coal. The heap of dust and coal thrown out of the small openings which had been made here had taken fire some days before I visited the place.

Good masses of bright 'coal,' however, can be obtained from this place.

The high dip (2 to 1) will render it necessary to work this coal in successive galleries one over the other. The whole of the coal can readily be extracted, and the walls suffered to creep gradually together afterwards.

The high dip, the unsolid nature of the coal, the tendency to self-ignition, and the irregular admixture of earthy patches, are all serious drawbacks to the profitable working of this bed of 'coal' or lignite. There is, nevertheless, a tolerable amount of good useful fuel here.

The inaccessibility of the locality is of course a question bearing rather on the cost of transport, which will be noticed further on.

2. Keura.—Towards the western side of the wide and open basin which occurs above the Keura gorge, and not far from the main scarp of the nummulitic limestone which forms the outer edge of this basin a bed of coal has been opened into by driving a small heading into it. The coal here is very poor, full of iron-pyrites and with layers and irregular masses of clay interbedded. It is altogether only 2 feet 11 inches thick, and both roof and floor are bad. It rests upon a blueish clay or shale with septaria-like concretions. This bed is seen in a fallen mass of the rocks, a large mass of limestone and associated beds having slipped down along the softer beds below. There is no prospect here of any coal being worked with any advantage. There is in the middle or near the middle of the 'coal' a small layer of shale which appears to be continuous and tolerably regular, and which divides the bed of 'coal' into two.

3. Pid or Pind.—In the lands of the village of Pid, and not far from a bungalow erected there by Mr. Purdon, some 'coal' has been opened into. It is seen on the steep sloping side of the hill facing the south, the bed dipping to the north or into the hill at 60° to 64° (2 to 1). The outer edge of the bed of coal has slipped down slightly so as to produce a smaller or flatter dip than this (about 40°) for the first few feet. Above the coal are some 15 inches of grey shale, and it rests upon a darker colored blackish shale, in which are strings of coal. These are more abundant in parts of the bed, and they show a tendency to form a second bed of coal. The coal itself is about three

feet thick, but has numerous layers and small patches of shale mixed with it. The coal, when pure, is good bright fuel, like the others a good deal broken up by numerous cracks and joints, and rapidly falls down into small fragments after exposure to the air. There is not quite so much pyrites here as in other places.

The locality is in some respects favorable; it is close to a good road and easily accessible, and probably a fair amount of fuel could be had here, But it will be expensive to work, as so little of the bed is exposed, and the whole of the coal extracted must be raised to the level of the outcrop for some time at least. Possibly the bed might be traced round the hill side to a lower level, but there is a thick covering of debris in most places, which prevents this being done without detailed search.

4. DUNDHOTE.—Passing across the wide plain spread out on top of the nummulitic limestone on which the village of Dundhote is perched, and dropping over the scarp of this limestone to the west, and down the steep slopes of the hill side, in a deep gorge which forms one of the drainage gullies, coal has been found; and a small extent of the bed had been excavated here. This coal is seen just on the edge of a great fault (or slip) which has brought the nummulitic limestone, and its associated coals below, into immediate contact with red and greenish grey marls of the salt series. The junction is clearly seen for about 200 feet in thickness: the coal has been brought up along the fault for a little distance, and is also seen just beyond it. The bed here is about two feet six inches in thickness, covered by greyish shales, and resting on blackish shales, with strings of coal. There is, however, no extent of this: it is only a small fallen mass of rock and coal, and is useless as any permanent source of fuel, which would be very quickly exhausted. The locality also is very inaccessible.

5. DUNDHOTE.—At another locality about a mile further north coal is seen, dipping to the west, in a small undercliff produced by a portion of the main scarp of the limestone having fallen, or slipped out from above, the main scarp being continuous along the hill side about a quarter of a mile to the east. In this small undercliff coal has been opened out—here the bed is distinctly split up by a band of sandy shale. There is some decent fuel in the layers both above and below this, but they are too thin to be productive—from 15 to 18 inches and from 10 to 12 inches. The 'coal' beds also are squeezed out and die away to the south, while to the north they are suddenly cut off. The whole is obviously only a fallen mass of no great extent.

6. DUNDHOTE.—'Coal' is again seen further to the north and west at the top of a long drainage gorge which passes up from the salt valley below to the main scarp of the nummulitic limestone, where this coal is visible. It is of the same general character, and offers no greater prospect of successful exploration.

7. NILA.—Close under the village of Nila, coal is seen just beneath the steep cliff of nummulitic limestone, on the top of which this village is placed. The coal is poor in quality, dips here 30° to 35° to the south-east. It is in precisely the same general position in the series as at all the other localities. Above it is grey shale about 6 feet thick, over which are hard ferruginous gritty shales, immediately above which is the nummulitic limestone thick and massive. The coal is

more than 15 inches thick, and below it there are about 8 feet of blackish shales with thin layers of flaky coal, underneath which again is a yellowish brown calcareous sandstone (fossiliferous).

8. Kuruli.—Near the village of Kuruli similar veins of 'coal,' with similar accompanying beds of shale and ferruginous clunchy clays, are seen dipping sharply to the west under a thick cliff of limestone above. A vast slip fault has here occurred, and on the top of the fallen mass the village of Kuruli is placed. To the south of this the limestone and associated beds are seen in junction with the red marls, having slipped down over them. The 'coal' is useless, as well as very limited in extent.

9. Noorpoor.—Near the northern end of the grand gorge which passes up from the plains to Noorpoor, and under the high cliff of limestone along the nearly vertical face of which the salt-patrol road has been carried, the blackish shales and associated coal are seen. This coal seems to be in very small quantity in the shales, and the whole seems to offer little prospect of any successful working.

10. Sowakhan.—As at other localities, the coaly seams are found under the nummulitic limestone, associated with clunchy grey clay or shales, and ferruginous beds. This point is just on the edge of a large slip fault, which has brought the limestone down into contact with the red and purple marly beds of the salt series. These latter are here nearly horizontal, dipping only slightly to the west, while the limestone on the contrary dips 45° to 50° to the N. N. E., or even N. E.; the fault line heading to the north-west—south-east. A very large amount of debris has fallen here, and to a great extent it conceals the section. The whole is, however, greatly broken up, and is of no extent, being only a portion of the rocks, far removed from its natural position.

11. Dehiwal.—A little patch of 'coal' and coaly shale was found in one of the lower spurs of the hills some few miles from Dehiwal village, but said to be within its boundaries. It is perfectly useless as a source of fuel, as it is only a small mass included in a heap of debris of all kinds, and even if it offered prospect of yielding any amount of fuel, this could only be extracted at the risk of life and limb. It is only a few feet in length, and varies from an inch or two to nearly two feet in thickness.

12. Kutta.—Under the Chamil Hill, near its base, coal occurs in circumstances very similar to those we have described in other places. This had been to a certain extent worked, and an amount of the coal had been removed for burning bricks I believe. It is said that the disturbed state of the country in 1857 put a stop to this work. The coal is seen at the base of a large cliff of the nummulitic limestone, which has slipped down nearly to the base of the hill, and is, within a few feet to the west, in actual contact with the red marl and sandstones of the salt series. The whole mass of limestone and coal underneath is a good deal broken. The locality is convenient from its proximity to the plains, but there is no prospect of any continuous supply. Indeed, I am disposed to think that almost all the coal that

could be obtained here, *without very heavy expense,* has been already removed. Further, the bed is of no thickness.

Like most of the other localities to which we have referred, this is only in a fallen mass of the rocks far removed from its natural position, and limited in extent and area; the dip here is also high.

13. CHAMIL.—Coal is again seen under the lofty scarp of the limestone at the north-eastern corner of the great line of cliffs which form the southern face of the Chamil plateau, and extend thence to Nursingphooa. In this angle of the cliffs a small stream forms a pretty fall over the vertical face of the limestone into a basin below, around the sides of which the 'coal' is exposed. This locality is very interesting, not only because the section of the coal seams and the associated beds are fairly seen, but because it is the only place in this part of the hills where the lignite beds and associated shales, &c., are seen in their true position, and unfallen. It may be interesting, therefore, to give here an approximate section of the beds, as affording a good point of comparison with those occurring about the same horizon to the east and west in the Range. The beds are regular and steady in dip, 12° to north 5° west. The section, neglecting all minor lithological details, is here (descending)—

	Feet.	Feet.
Sold nummulitic limestone	100	
Pseudo-conglomeratic beds of ditto	50	
More solid ditto	50	
Flaky and shaly beds, with a few more solid limestone beds ...	20	
Solid limestone more flaky and laminar towards bottom ...	30	
Earthy and nodular ditto	2	
Solid, hard, regularly thin bedded	2	
Ditto, in nodular rounded masses, with irregularly developed layers of shaly matter and of pure limestone	30	
	—	284
Blackish earthy shales, with some thin layers of sandstone, or sandy shales	10	
Blackish shales, with a few indistinct strings of coaly matter	10	
	—	20
Sandy and shaly beds, hard and ferruginous, with nodules of iron-pyrites	1 6	
Earthy, sandy and ferruginous beds	5 0	
Ditto, clunchy, pyritous	1 6	
	——	8
Coal, not bad fuel, varies from 6 inches to 10 or 12 in thickness	9	
Blackish sandy bed, with strings of carbonaceous matter, and pyrites	1 6	
Black shales	2 0	
Coal, fine jetty coal	·6	
	——	4 9
Shales, black and clunchy, with strings of coaly matter, small and irregular	2 6	
Sandy ferruginous clunch, with pyrites	1 0 to 2 0	
Black shales, with nodules of clay-iron-stone in irregular strings	4 0	
Black earthy shales, breaking up readily into small dice-like squares; some irregular thin layers of sandy clunch in this...	3 6	
Hard calcareous sandstone	2 6	
Sandy shaly beds, dark black grey	3 0	
Hard calcareous sandstone	1 0	
Sandy shale as before.		

But we need not proceed further or lower in the section, as no trace of coal is seen below: the rocks seen here are of the highest interest geologically.

From the above section, it will be seen that we have here very distinctly marked the separation of the coal into two beds, or rather groups of beds, a separation which we already noticed as just seen at Keura, as more distinct at Pid, and then more so at Dundhote. Here there is above a group of shaly beds with strings of coal, 20 feet in thickness, under these some eight or nine feet of sandy beds of varied color, and then again beneath another group of shaly beds with distinct seams of coal. It will also be seen here that the lower group of shales is richer in coal than the upper.

So far, however, as any practical result can be looked for there is here no prospect of any useful workable coal. What there is, is good in quality, but seams of 6 or even of 12 inches in thickness, supposing them to be regular, would never pay, especially under a thickness of 300 to 400 feet of solid hard rock. The dip here is favorable, being, as already stated, only 12°; the place is not very difficult of access, but there is no workable quantity of coal.

14. Sungle-wan.—The next locality, proceeding westward, where coal was seen, was up the Sungle or Sungle-wan. The position is about one mile to the west of the village of Arara, in the deep gorge which has here been cut through the limestone and other rocks; and is close to a small herd-feeding hamlet called Diliali (from the trees which grow near it).

The lignite beds are seen at the level of the water in the bank of the stream, being only a small patch under a large talus of debris at the foot of the high scarp of limestone. There are two thin seams, the upper 6 inches the lower about 10 to 12 inches, with hard sandy clays between. The dip is to south-east at 30°. A broken mass of blackish ferruginous shales covers the coal. The whole is, however, only one mass of broken debris, cliffs of which, without any solid rock, of fully 100 feet in thickness, are seen above the lignite. The same beds are seen, not far off, in a little water-course up the side of the talus, here also much broken up.

There is here no extent of these beds, even if they held out any prospect of being profitably worked, which they do not.

15. Amb, or Umb.—Far away below this beautifully situated and most interesting village, Amb,—at the bottom of one of the deep side valleys which unite with the main-gorge over which the village is placed, a small fallen mass of nummulitic limestone, with a portion of the shaly and coaly beds underneath it, has been hunted up. The whole mass can be readily walked round, as it rests clearly on the red marls of the salt series below. It is not altogether more than about a hundred yards long, and not fifty in width, and under only a small portion of this do the coaly beds occur, of no value and of no extent.

This is the most westerly locality in which the so-called 'coal' had been noticed to the east of Indus river. Trans-Indus—similar deposits

had also been found in several places under the bold cliffs of the Lowaghur and Chichali Hills, some of which I visited.

16. Kalabagh.—In the hill behind the prettily situated and busy village of Kalabagh, small irregular strings and patches of coaly matter occur in the beds of alum-shale or 'rol' (which are so largely worked for the manufacture of alum, a branch of industry which has been located at Kalabagh for many generations), and especially in the lower group of these shales. But these irregular patches of coal have never been sufficient to induce any attempt to extract them as coal, although their occurrence in the shale makes the latter more easily roasted and worked. The 'coal' of Kalabagh we shall allude to presently.

At Kalabagh the nummulitic limestone and its associated shales and beds, which are not seen for some distance from the Indus to the east, come in again. Under this limestone here, in exactly the same position as the coal occurs in the more eastern portion of the Salt-Range, we find a thick group of beds of alum-shale, with small and irregular strings of 'coal'. These rest upon a mass of highly colored and variegated sandstone and shaly beds, which are here not less than 80 feet in thickness; under these again comes another group of similar black and pyritous shales, with strings of coaly matter. 'Rol' or alum-shale is extracted largely from both these groups of beds, but chiefly from the lower.

East of the Indus, and under Sakesur Hill to the south, precisely similar beds are seen. They are not quite so largely developed, but the strongly marked colors of the beds show very distinctly in the various sections to the south of the hill. Alum has been extracted here also to a limited extent.

17. Kotki.—Passing on to *Kotki*, at the southern end of the Chichali Pass, we find there the same marked groups of beds of aluminous shales occurring under the nummulitic limestone, and with precisely the same general characters. Here also strings of coal and coaly matter occur through these alum-shales, and, as in other places, more in the lower than in the upper beds.

18. Chushmea.—In a deep gorge, which forms one of the many drainage channels along the face of the hills around Chushmea, and high up in the general scarp of the hill face, some thin seams and irregular patches of coal were noticed in the same alum-shales as before. They occur in nests and irregular strings in the alum-shale of no thickness. The coal is not bad in quality, but there is no prospect here of any profitable working.

19. Mullakheyl.—Up the stream which issues from the hills close to Mullakheyl, and just at the bight of the great curve which the range here makes to the south, some irregular strings and nests of coal were noticed in the beds, which here represent the upper alum-shales. But they are useless, from the small quantity in which they occur, as any permanent source of fuel.

Oolitic Coal.

Kalabagh and Kotki.—There still remain to be noticed two or three other localities where coal has been found, but which have been reserved for mention here, inasmuch as they belong to an entirely different geological age from those beds which we have just been noticing. These are at Kalabagh and Kotki.

Under the nummulitic series in the western portion of the Salt-Range (but not extending into the eastern portion) there occurs a group of beds of sandstones with a few earthy shales, and a few imperfectly calcareous beds. In many of the beds masses of jet-like coal occur, which have a beautiful lustre, and a conchoidal fracture, but in which the woody structure is perfectly preserved. These are especially abundant in one bed of shales (about 1½ mile west of Kalabagh), and from this bed the 'coal' of Kalabagh has been extracted. It consists solely of these carbonized masses of wood, there is no regular bed of coaly matter, but these masses are extracted from the shales in which they occur. As might be anticipated from the mode of their occurrence being all pieces of wood carried or drifted into the mud which now forms the shale-bed in which they occur, and in which they are all found prostrate (not in the position of growth) and fragmentary, the distribution of these is very irregular, and even where they are most abundant, they constitute only a fractional portion of the entire bed. Colonel A. Taylor, who examined this locality in 1863, estimated that these masses of coal did not form more than one-twentieth part of the whole bed. Even this I consider too favorable an estimate. I will consider the probable quantity procurable here further on.

At Kotki, masses of precisely similar 'coal' are found in a sandy bed of yellowish color, which is exposed in one of the side gorges which drain into the main glen of the Chichali Pass, close to the village of Kotki. This bed is at present very inaccessible, and the quantity seen is not sufficient to justify any expenditure in improving the communication.

At Mullakheyl also traces of masses of coal in a similar position are seen, but only in a very small quantity.

Some of the beds associated with those, containing such masses of coal of carbonized wood, contain also an abundance of fossils (Belemnites, Ammonites, &c., &c.,) which at once indicate their geological age to be of the Oolitic period, and therefore widely separated from the beds above, which are connected with the lower tertiary or nummulitic limestone.

We have thus very briefly passed in succession the several localities where coal has been hitherto noticed in the Salt-Range, and in the adjoining portions of the ranges, Trans-Indus. A few general remarks now will suffice.

One of the most interesting facts connected with these deposits is the remarkable constancy with which the beds containing this coal appear to hold their position from the extreme eastern end of the Salt-Range to the furthest point in the west, to which our researches

extended. Recent researches in Sindh, and the discovery of small beds of coaly matter west of Dera Ghazee Khan, and in other places between, point to a further extension of the same fact. But while thus continuous in one sense, it is equally certain that there is a considerable variation in the thickness and composition of these beds. And at first looking to these facts, that the beds were, on the whole, continuous, and at the same time subject to considerable variation, I was led to suspect that possibly the few, and in some cases distant, points at which these beds were seen would not be at all sufficient to prove what the general character of the deposits might be. And that seeing that these localities, in by far the majority of cases, were only in places where fallen masses of the hill sides had slipped bodily down from their true position, it might be the fact that, by careful search in the intermediate parts of the range, and judicious selection of the more favorable points as to dip, &c., beds might be found which would justify a hope of yielding a large and continuous supply of fuel.

I believe, however, that this is not the case; and for these reasons. The total thickness of the whole group of rocks in which the coal is, at Baghanwalla, does not exceed 100 feet, and there this coal is in one well-defined bed, with only a slight admixture of earthy matter. If we now pass to the magnificent escarpment of the Chichali and Lowaghur Hills to the west of the Indus, we find that this same group of beds has a thickness of fully 3,000 feet, and that the so-called coal occurs in two very distinct beds or groups of beds, widely separated by some hundred feet of thickness of variegated beds of bright colors, white, yellow, red, grey, olive-green and nearly black, through which impressions of rootlets and stems occur here and there. These may be taken as the two extremes of the range over which we have seen the coal. We have already given another section intermediate but nearer to the east end of the range (at Chamil), and there it was seen that the coal occurred also in two beds separated by some feet of intercalated beds. Again, further west, if we take the section seen to the south of Sakesur Hill, we will find that here the beds intercalated between the two groups of shale beds, in which the strings and layers of lignite occur, have attained a very considerable thickness and form by their very bright and contrasting colors a marked feature on the hill sides.*

When first noting the appearance at the Keura seam of coal of a thin layer of shale intercalated in the bed, I did not see the full importance of the observation. Passing west to Pid this feature increased at Dundhote, the beds separating the two layers in which coal occurred had increased to between 2 to 3 feet. At Chamil these beds were fully eight feet. Under Sakesur they cannot be less than one hundred, increasing to considerably more as we pass westwards. Thus we have, then, continuous evidence that the single bed of some three feet thick at Baghanwalla, which is tolerably free from earthy admixture, becomes split up into two beds as we pass westwards; that these two beds become gradually thicker by the increase of the amount

* The alum-shales, in which the coal occurs, have been worked to a small extent for alum under Sakesur Hill.

of earthy matter or mud, and gradually also more widely separated by the development of sandy and earthy and calcareous beds between, until towards the west of the range, we have the single bed of Baghanwalla not more than three feet thick, represented by the two distinct groups of beds, the upper and lower alum-shales having a thickness of more than 200 feet, and separated by a well-marked series of beds which themselves are equally thick. And in these black carbonaceous shales (alum-shales) there is here and there only a thin string or layer of coaly (vegetable) matter. This alteration in the character of the deposits is a continuous and a gradual one,* and it leaves no doubt that there is a regular steady and continuous diminution in the amount of the coaly matter in these beds, coupled with an equally continuous increase in the amount of the earthy ingredients as we pass from the east to the west. This fact being established, I think there can be little hesitation in rejecting any hope which might have suggested itself of the discovery, at points intermediate between the localities I have noticed, of beds of superior quality, and more favorably placed for working.

There is no question that Dr. Fleming and his colleagues were correct in stating, that the bed near Baghanwalla held out much better prospects of successful work than any others in the range.

Quality of Fuel.—The quality of the so-called 'coal' is an important question. Specimens taken from the Baghanwalla bed, from the small pits at Pid, from Dundhote, from Kalabagh and other localities, have been analysed, and though the results have, as might be anticipated, varied considerably, there is little question that the average quality of the 'coal' represents a good useful fuel. It is for the most part rather difficult to ignite at first, throwing out a large quantity of dense smoke (and in most cases with a marked sulphureous odour), but when ignited it burns well, and with abundant flame, does not cake much, and with ordinary care yields but little clinker. Tried practically in the locomotives of the Punjab Railway, both at Lahore and at Mooltan, it proved very successful. It was found to answer well both in getting up and maintaining steam for an ordinary train travelling twenty-five miles per hour. At Mooltan, Mr. Nethersole, who tried it, states that it answered well, but requires screening and the foreign matter picked out; there was also a quantity of dust from the brittle nature of the coal, and the fire bars required attention.

In all these experiments, it ought to be remembered, that if such a 'coal' as this were to be permanently used, considerable modification in the arrangement of the furnaces and fire bars would be required, and that it is scarcely fair to take, as trustworthy results, the experiments tried with furnaces specially adapted for burning wood. The coal has also been tried in the steamers on the Indus, and a very favorable opinion of its quality given. The Engineer in one calculated that weight for weight it was four times as effective as wood.

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* There is no necessity here for giving any minute details of measured sections.

There is, therefore, no question that, with ordinary care and attention and with slight changes in the mode of stoking, &c., this 'coal' would prove a very effective fuel, although it cannot be considered a first-rate coal. It is undoubtedly a better fuel than wood, and weight for weight of far greater value, and this relative value varies from about 2·5 to 4 to 1, or one maund of this 'coal' will be equal in effective work to 2·5 to 4 maunds of ordinary wood.

QUANTITY.—The next question of importance is what quantity is available?

For the reasons I have given above, I put out of the question any one of those localities where coal has been said to occur and which lie to the west of Pid. Possibly a small quantity of coal will be obtained from under the Dundhote scarp. But I think it safer to reject the consideration of this, which is at best problematical, and which will certainly only yield a limited supply. For *local* purposes some might, doubtless, be procured, but the 'coal' occurs in such small quantities that it will never pay to extend the workings to any length.

Taking Baghanwalla, then, as unquestionably the most promising of any of the localities, we can here make a rough approximation to the quantity of 'coal' which will be available at a moderate cost, that is, without going to any great expenditure for machinery or other such appliances. I put aside altogether any calculation of what may occur (and I suppose does occur,) at depths to which it most indubitably would not pay to drive the workings for such a coal as this.

At Baghanwalla, the seam, when cut through in the water-course, was 3 feet 6 inches thick, occasionally a little more. This I have already given my reasons for considering to be more than the regular or general thickness of the bed. To the west, the bed holds on steadily in direction, but gradually thinning out for more than a mile; to the east it can be seen for more than quarter of a mile. We may, therefore, take the whole length as about 2,000 yards, and we may take the average thickness as two feet six inches, the portion which lies above the water level, and which is therefore most readily accessible and could be worked by adits, without pit sinking, may be taken on the average as 100 feet thick. We would then have $6{,}000 \times 2{\cdot}5 \times 100 = 15{,}00{,}000$ cubic feet of coal; take from this ten per cent. to allow for irregularity of beds, and we would have 13,50,000 cubic feet, which may roughly be taken as equivalent to maunds. This would be equal to about 45,000 tons of coal. If the workings were carried down, say 20 feet, below the water-level, and I scarcely think it would pay to go much further, we should have, in addition to the quantity given before, $6{,}000 \times 2{\cdot}5 \times 20 = 3{,}00{,}000$ cubic feet, or deducting as before one-tenth, equal to 2,70,000 cubic feet, or maunds of 'coal,' making a total of 16,20,000 cubic feet or maunds of coal.

From this, at least one-fourth must be taken for waste, small coal, dust, impurities, leaving 12,15,000, or in round numbers 12 lakhs of maunds of coal.* This quantity ought, I think, to be available here.

* 12,00,000 maunds, equivalent to about 40,000 tons, is however a quantity so insignificant that the prospect of such a return would not justify even a *small* expenditure for mechanical appliances.

There can be no question that a considerable amount of fuel can be procured.

I do not think it necessary to go into any closer calculation, and indeed the data for rendering such satisfactory are wanting. I think it quite sufficient to keep to the roughest approximation. Everything tends to show that such an approximation is more likely to be above the truth than under it, and I do not think it necessary even to attempt this rude approximation for any of the other localities.

The natural point of supply for the Indus steamers, for which this fuel would prove most valuable, would be at Kalabagh or from some other locality to the west of the river. At Kalabagh unfortunately however the supply is very short. The mode of occurrence of the 'coal' here has been already noticed. The bed in which it is so irregularly distributed is cut off to the west by a fault, (? slip) which brings totally different beds into contact with it transversely while to the east the bed is gradually squeezed out to nothing along the great folding or contortion of the rocks here. The total length here seen is not more than 900 feet, while a considerable part even of this length must be deducted as useless. On either side of the small stream which has exposed it, the beds rise considerably above the level of the water-course. I have already stated my belief that the stems and portions of trees now altered into coal which occur distributed in this bed, do not constitute much more than one-twenty-fifth of the whole mass. Taking these facts as the basis of calculation, the quantity of coal which could be obtained, were the whole of the bed, which is now above water-level, to be excavated, would not be more than 40,000 cubic feet. If the works were carried down below that level, say for 20 feet, an addition of about 10,000 cubic feet might be obtained, say a total quantity of some 50,000 cubic feet, which we may roughly take as equivalent to maunds; take 10 per cent. off for waste, contingencies, &c., and we would have some 45,000 maunds of coal as the total quantity which there is any probability of being able to obtain here at any reasonable cost. And owing to the necessarily uncertain distribution of such pieces of coal, from the very nature of their deposition, it is by no means certain that even this quantity would be obtained. What the consumption of coal for the steamer traffic of the Upper Indus may be, I cannot say, and I cannot therefore form an estimate of how long such an amount of coal could be calculated on for their supply. It was stated that a contract was offered to supply this coal at the river bank at the rate of three maunds for a rupee. At that rate it would, so long as it lasted, be decidedly cheaper than wood, which, at Kalabagh, is supplied to the steamers at five maunds for the rupee. But I am satisfied that this rate will not pay for the extraction and transport of the coal, excepting for the first few months, when the coal is easily accessible.

I do not see that there is the slightest prospect of any large supply being obtained here, or any that would justify expenditure for any machinery or other appliances. And I would therefore suggest that the Natives be encouraged to extract and bring down to the river what quantity they can procure for the use of the steamers. They cannot injure the prospect of any future workings, and they may obtain some

useful fuel, which may possibly be sufficient to supply a demand like the present for some years to come. This coal might possibly be advantageously reserved for the use of the steamers on their passage from Kalabagh to Mukkud, where higher power is required than in the lower reaches of the river.

The beds at Kotki and the Chushmea are too far from the river bank to be of much use even if they were not so unpromising as they are believed to be. There too it is possible that Native labourers might be encouraged to extract and bring to the river bank a small supply of coal.

In conclusion, as regards the quantity, I may refer to another very important consideration in all such enquiries regarding coal. I do not see the remotest chance of other beds, either above or below those to which I have been referring, being discovered. The sections of the rocks are thoroughly exposed, and not obscured by even a shrub; and did any such beds exist, it is, I think, impossible to imagine that they would not have been exposed in some one of the many deep gorges which score the hill-sides.

Market and demand.—There is no local demand for this fuel in the Salt-Range, and the markets to which it must be sent are at present well defined. The great demand first would be for the working of the railroads in the Punjab and for the steamers on the Indus. The chief market is therefore at once indicated at Mooltan. At Lahore there would of course also be a considerable demand for such fuel, if it could be brought there at reasonable rates, but the long and difficult land carriage at once bars this. In order to reach Mooltan, this coal would first be carried on camels, or by other means to the bank of the Jhelum at Pind Dadun Khan, or wherever it might be found most convenient to ship it, and there transferred to boats, in which it would proceed direct to Mooltan.

I am sorry to say I was unable to arrive at any trustworthy conclusions as to the actual cost of such transport. The data on this point given by those who ought to have known the circumstances were so opposed that, without the local knowledge which I did not possess, I could not reconcile them. By some, it was said that present rates of freight on the Jhelum and Indus were quite exceptional, caused by the great demand for boats to carry away the cotton crop to the seaboard, and that, therefore, it would be quite unfair to calculate the cost of transport of the coal at such rates. It was also asserted that by taking advantage of certain seasons of the year, when the demand for tonnage was not so great, the coal could be sent down at lower rates.

On the other hand, it was urged that the present increased rates were by no means due solely to the temporary demand for cotton freight, but to a general increase of the traffic on the river, and that, to whatever cause this increase was due, there was little chance of a return to former prices. It was also, by those holding this view, thought, that no advantage would be gained by sending the coal down only at certain seasons.

In this divided state of opinions, I am unable to say what the cost would be. I think it certain that here, as elsewhere in every similar case, the attempt to send down any large quantity of coal by boats on the Jhelum would inevitably result in an increase, not a decrease, of the charge for freight. And I think also that it be found essential that boats should be more specially devoted to the trade, than seemed to be generally contemplated. Further, 'coal' like this of the Salt-Range should be sent away as quickly as possible after it was raised, and it would not answer to keep it standing, for perhaps months, on the river bank.

I do not, therefore, so far as general considerations enable me to arrive at a conclusion, see the slightest prospect of any diminution in the cost for transport of this 'coal' to Mooltan.

According to the most favorable calculations then, it appeared that this coal could not *now* be delivered at Mooltan for less than 12 annas per maund, this being charges solely for carriage, and not including anything whatever for the cost of the coal itself, cost of superintendence, losses, risk, &c. If we add something for all these, the cost at Mooltan cannot be taken at less than 14 annas per maund, if it did not amount to a rupee. According to other calculations this cost would exceed one rupee per maund. We may suppose that this cost would be constant so long as the supply of coal lasted. And it will then be easy to see whether the coal will, in point of economy, contend with, or be superior to, wood. One maund of this coal may be considered as equivalent in effective work to about three maunds of ordinary wood. The price of wood varies so largely in different places that it would be idle to enter into details. But I may state that there are few places within reach of this coal, where three maunds of fair wood cannot be had for a rupee.

I do not, therefore, anticipate that at the present this coal will prove much more economical than wood. Along the line of country, where the largest demand for this coal will exist for some time to come, I am informed that there is now an abundance of wood, and that the supply is ample to meet the demand for some years to come. And further, the large extension of forest contemplated by and being carried out under the Punjab Government will, after not very many years, tend to keep up this supply of fuel.

My conviction, therefore, is that these very limited deposits of mineral fuel in the Salt-Range can only be looked to as supplementary to the ordinary supplies of wood fuel in the country. It may, therefore, be an important question, which, without greater local knowledge than I possess, I could not venture to decide—whether the coal beds would be more effectively brought into play now, or some eight to ten years hence, when the present supply of wood will be very materially diminished, and before any new plantings come fully into operation for the supply of timber and fuel. This is, however, worthy of careful investigation.

The foregoing brief sketch of localities where coal is known in the Salt-Range and in the Trans-Indus district adjoining shows that there

is in places a moderate supply of tolerable fuel, that this is of fair quality—everywhere charged in greater or less degree with iron-pyrites (' brass' of miners), and that it will therefore be all liable to spontaneous ignition on exposure,* that it is greatly jointed and very fragile, rapidly and easily breaking up in small pieces, and that the localities where it occurs are difficult of access, and the 'coal' itself at inconveniently high angles.

Indeed, I would add that while I have already expressed my own opinion, that the 'coal' from some of these localities can be to a certain extent profitably utilized, I feel certain that it is only in countries where, as in the Punjab, the question of the supply of fuel has become one of the very highest and most vital importance, as affecting the most ordinary improvement of the country, that such deposits of lignite would ever be worth working at all. Every case of this kind has however its own peculiar aspects, and here it may, and, I think, will be worth while to economise this coal so far as it goes.

SALT.—My attention was also directed by the Hon'ble the Lieutenant Governor of the Punjab to the valuable salt mines and quarries in the districts I visited, with a view to suggesting any improvements or alteration in the system of working adopted.

The salt deposits of the Salt-Range and adjoining districts are one of the most remarkable and wonderful features in the country. Nowhere else in the world are deposits of such vast extent and purity known to exist. From the earliest ages, to which any records extend, they have formed the source of supply of this valuable article to all the adjoining country, and since they have passed under British control, the amount raised from these mines has vastly increased. During the year 1862-63, a total revenue of Rs. 30,31,568 was derived from the Salt Department alone, from the mines of the Salt-Range.

The importance of a careful and well devised system of working these mines is therefore evident.

SUPPLY.—The supply of salt in these districts may be considered practically inexhaustible so far as quantity is concerned; but while this is the case, it must also be remembered that every day's labor tends to increase the cost of obtaining this supply, and that, therefore, on this ground alone, if not on higher ground, it is most important that proper economy should be exercised in the extraction of the salt, and that proper precautions should be taken to obviate the present excessive waste of so valuable a material. It is clear also that proper steps should be taken to secure the safety of the miners employed, so far as practicable.

And further that every facility should be given to the merchants or buyers to obtain the commodity for which they come, without delay or any vexatious interference.

In considering these mines with regard to the present system of working, and the consequent safety of the miners, I think it most essential, that two very different things, which have been confounded

* There is much less fear of this in the dry climate of the Punjab than in Bengal or other damp districts.

in all the papers I have seen on these points, should be kept perfectly distinct, namely, the present state of the mines, and the present system of working. It has, I think, been much too hastily argued, that because the present state of some of these mines is dangerous, the present system of working is radically bad. Now the present state of these mines is in a very small degree due to the operation of the present system of working. The immense unsupported openings which exist in some of these mines, and in which there is unquestionably some risk of falling in, are not the result of the present system of working at all; they existed long before the mines passed into British management,* and were formed under the Sikh rule, or even at an earlier period. And for these the Salt Department is in no way responsible: whereas under the present system many of the galleries and headings which are now being driven in the salt, are as well put in, and as well worked as in any mine in the world.

These immense vaults are the grandest and most striking excavations I have ever seen. In size and extent they far exceed any opening in any mines in the world, and recall rather the immense chambers of such beautiful caves as Adelsberg, than the artificial excavations of mining industry, while the sparkling purity and brightness of the salt, when freshly broken, produce the most lovely and harmonious effects of colouring.

There are undoubtedly parts of some of the mines which are dangerous, and where slips and falls may occur, but this is the case in every mine, and it is easy to avoid such, and to obviate any fear of accidents by arranging that the work should not be carried on in those immediate places.

When the mines first passed under British management, it is clear from the descriptions given by those who had visited them, that they were in a greatly more neglected condition than now, and that they were in fact only accessible with considerable difficulty and risk. The admirable works constructed under the direction of Mr. W. Purdon in 1854 and following years, by which the entrance to the mines was opened out, the streams bridged, and a good road made to Pind Dadun Khan on the Jhelum, were the first great improvements, and these tended to increase the trade in salt immensely. These all remain and bear lasting testimony to the skill with which they were designed, and the ability with which they were constructed. And it is vastly to be regretted that improvements of a similar kind have not been steadily and systematically carried out since.

I have said that the present state of the mines is not due to the present system of working. It may be well to see what that system is.

All the miners are directly under the control of the Collector of Customs. He, directly or through his officers, gives permission for cutting and removing salt, and points out where it is to be cut, fixes the price to be paid to the men engaged, settles all the miners' disputes, and to him they all look as to their master and head. Outside the

* See Jameson on Geology of Salt-Range, Journal Asiatic Society, Bengal, 1843, p. 183, &c.

mines on the other hand, and, by a much questioned but assumed right, inside the mines also, all works, roads, bridges, &c., are under the Executive Engineer of the district, and come, therefore, under a totally different department. The right of the Engineer to interfere as regards the working of the mines may never have been actually disputed, but from the fact which I have mentioned above, it is perfectly obvious that the miners never will freely obey his orders, if he gives any, inasmuch as they look to another head altogether. And, moreover, he has no power whatever of enforcing those orders, nor of punishing any infraction of them.

On the other hand, the Collector of Customs, although held responsible for the proper collection of a revenue amounting to (nett) £300,000 per annum, never has had permission given to him to spend one sixpence in the improvement or even for the safety of the mines, unless after a tedious and possibly unsuccessful series of references from one authority to another. If a pillar gave way, if a road were stopped, if a breach occurred anywhere, he had not authority to expend even five rupees in removing the obstruction or in securing the safety of the mine. He was held responsible for obtaining the full supply of salt, and yet he had no power to adopt any means, although fully aware how urgently such means were required to facilitate this result. The position was, in my mind, an absurdly anomalous one. And I am compelled to think, that a fair estimate of the difficulties under which the salt officers have labored, neglected, unsupported, and even thwarted, would bring into strong light the credit due to them for the steady and continuous zeal with which they have labored, and labored with eminent success, to increase the revenue and maintain the supply from which that revenue has been derived.

It is, I think, under the circumstances I have noticed, quite clear that there is only a choice of two systems in attemping any improvement of the present—either the Collector of Customs and the Customs Department must be made responsible for all, and facilities given to him to carry out the work with proper appliances and aid: or he must be relieved *in toto* of any responsibility of getting the salt, and be confined solely and entirely to realizing the duty on salt obtained from the mines under other control. It is quite impossible, it is simply contrary to human nature, that two totally different departments, with different officers, different modes of conducting work, different ranks and grades, can under any circumstances be brought to work harmoniously in such a place as a mine. If there be any place more than another in which quickness of decision and determination be requisite, that place is a mine. There must there be but one controlling power—one head. And few other employments demand more careful experience, and more continued attention, than such work. It is folly to place any one in charge of such works, to give him perhaps a few months to become acquainted with the peculiarities of the place and of the work, and then to move him somewhere else, and send another new to the district, new to the mines, new to the miners. Let any one who has not been in the frequent habit of visiting mines endeavor simply to find his way through one of these large excavations, and he will soon

be convinced of the necessity of a little knowledge of the locality and its peculiar conditions, before he can safely undertake any work.

I believe the present system of managing these mines to be faulty in a high degree, and I have above briefly suggested two plans, either of which would, I think, be a great improvement on the present system. These are simply,—take the actual working of the mines and the extraction and supply of salt entirely out of the hands of the Customs Officers; or—give the entire control of this working to the same Officers *with proper aid*.

Either of these plans will necessarily involve some additional expenditure. If the first be adopted, a separate establishment must be entertained for weighing over, delivering, and for storing the salt; godowns or enclosures where it may be kept must be erected and caretakers appointed who shall watch the salt, both while in the hands of the working establishment at the mines, and of the Customs Officers before delivery on payment of the duty. It requires, I think, little consideration to see that all this will involve the necessity of a considerable additional outlay, and the probability, if not the certainty, of continued bickering and disputes between the two establishments.

If the second plan be adopted, it will be essential that a mining Engineer be appointed, attached to the Customs Department, whose sole duty it would be to direct the workings, to see to the safety and preservation of the miners, and of all works within the limits of the salt-mines-boundaries, but nothing beyond. He should have power to expend at once, and on his own responsibility only, a small percentage on the return of the salt for the safety and improvement of the mines; and for any larger works, requiring a heavier outlay, he should, I think, be obliged to refer *directly* to the Secretary to Government in the Public Works Department, and to obtain the sanction of Government.* For all matters requiring immediate attention, and which should be undertaken without any reference or other delay, a small percentage on the out-turn would suffice. But these works *must* be placed absolutely under the immediate control of the engineer on the spot.

This plan will also involve additional expenditure and perhaps a little more than the other; but it has the strong recommendation that does not (so far as I see) involve the risk or certainty of disputes and differences, and does not bring the separate departments into collision. Under this system, I think, the regularity of the workings, the safety of the miners, the full supply of salt, would easily be secured, waste would be checked and prevented, labor be economised, and all would proceed harmoniously.

I would not be misunderstood. I am quite satisfied that the system of working these mines is capable of being vastly improved; but

* To induce such an engineer to remain at his post, and thus to acquire the advantage of increasing experience, he ought, in my mind, to be permanently attached to the appointment, and his pay (dependent of course on good conduct and efficient discharge of duty) should steadily rise at a fixed rate and to a fixed limit. With a prospect of this kind I think fully qualified men could be induced to enter the service, at comparatively low rates at the present—say Rs. 500 per month now—to rise by Rs. 50 per month per annum, so that after ten years' work he should have Rs. 1,000. This to be permanent.

I would also bear very strong testimony to the wonderfully good condition of the mines I visited, considering the difficulties under which the Salt Department has labored with regard to their working.

A few words are demanded as regards the miners. I found them all along the range discontented. They complained, and to some extent justly, that the price allowed them for hewing and removing the salt fell unequally on them, rather than that it was too little. It is difficult to avoid this. I do not see how it can be obviated, unless some plan of setting each part of the mine by public bidding to be cut at such a rate per 100 maunds be adopted. To a great extent too this inequality adjusts itself. They complained also of the loss of certain privileges of ground or of grazing, which they had hitherto always enjoyed. The justice of this claim I am unable to speak to. They had, I believe, made some threat of leaving the mines if they did not obtain these assumed rights, but their claims had been rejected, and they were told they were merely coolies or unskilled laborers employed as required. I do not pretend to offer an opinion on a matter which did not come before me in detail; such claims, however, urged by illiterate men, who know little of legal distinction as to rights, invariably have some foundation. And although their skill as laborers is not of the highest order, still it is such as has taken time to acquire. Every one of these miners has, as it were, served an apprenticeship to his trade; and a point, which in all the papers I saw on the subject appears to have been entirely overlooked, but which is of much importance is, that they are only employed, as such unskilled laborers, for one-half the year. If they are expected to remain and come back to their work after the lapse of six months, during which they receive no pay whatever, it does appear to me tolerably certain that they must have, or have had, some rights or privileges tending to secure this attendance. The contract to give six months' notice before leaving their work, now exacted from these coolies, seems to me, if not illegal, highly impolitic; if it were not that it is known by the men to be useless, as there is no penalty attached to a breach of the engagement. The employer does not, moreover, contract to give this laborer employment for the six months, though he demands notice of quitting. The true and only safe way of retaining the services of such men is to give them a fair remuneration for their work, and there will then be no necessity in these mines, any more than there is in any well regulated mines in the world, for any such contracts or engagements.*

As regarded the trade in salt, I heard much concerning some difficulties and obstructions under which it labored. Some improvement might at once be made in the system of bringing the salt from the mouth of the mines to the weighing house, from which it is finally passed into the hands of the buyer. I think under whatever department the workings be placed, the purchaser should have nothing whatever to say to the salt until he received the quantity he required from

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* It was stated to me that the whole amount of money value involved in this long continued dispute as to the rights or supposed rights of cutting grass or grazing was about Rs. 400 per annum or thereabouts. This sum does not represent much more than one-half hour's working of the mines of Keura alone.

the Government weighing-house. This would make no difference in the cost to the buyer, nor entail any loss of revenue to the Government, while it would greatly simplify the trade.

The main complaint, however, was as regarded the transport of the salt. By far the largest mines in the range are those at Keura, near Pind Dadun Khan. Of the immense supply derived from these mines, nine-tenths nearly pass over the bridge of boats across the river Jhelum at Pind Dadun Khan, and is thence distributed over all the Punjab. Under present duties, this salt goes as far as Kurnal (and occasionally even to Delhi), where the North-Western Salt meets it on equal terms.

The immense supply for this very extended area all passes over the bridge of boats at Pind Dadun Khan, and great and loud complaints are made of the tolls there levied, and, so far as I can see, most justly.

The tolls established at this bridge have been, I presume, fixed, as in other places, with a view to ensure a return sufficient to cover, and more than cover, the expense of maintaining the bridge and its approaches. In this way, a certain sum is demanded for a laden camel, a laden bullock, &c., and a certain much smaller sum for an unladen or empty camel, or bullock, &c. But in the case of salt the charges are different, and an additional toll of half an anna per maund of salt is charged over and above these fixed rates. A camel, for instance, carrying a load of grain, no matter of what weight, is charged four annas, the fixed toll for a laden camel; but if the same camel return again with a load of salt, it is charged four annas plus half an anna per maund for the salt. I cannot see on what principle of justice or equity the nature of the load can be held to authorize this additional charge. The injury done to the bridge is the same; and, further, if the load be charged for separately, the beast carrying it should certainly not be charged for as laden, but as empty. I do not pretend to say whether four annas be a fair charge for a camel when laden, or whether half an anna per maund be a fair charge for the passage of salt. These are not the questions under consideration (nor could I solve them, having no data before me), but it needs no investigation to maintain that, to charge both the animal carrying the load as a laden beast, and to charge also for the load he carries, is contrary to all principle.

In consequence of this mode of charging toll, and to avoid this heavy demand, the animals crossing the bridge are most cruelly and dangerously overloaded, and compelled to carry double, or even more than double, their ordinary loads. A camel is made to stagger along under 12 to 14 maunds, whereas 6 is a good load for it, and a bullock is made to carry more than a camel ordinarily does.

This charge is in fact a transit duty on salt over and above the heavy tax of Rs. 3 per maund which it had already paid—a duty levied in the most objectionable way, and levied further, it must be said, apparently for the benefit of the bridge contractor alone. The bridge is maintained by Government at a cost of about Rs. 2,000 per month while open; police at the cost of Government are placed there to keep order; an establishment kept up for its repair; and the contractor has

only to collect the tolls, and pay his annual rent. Now the toll on salt alone (the quantity passing the bridge is easily ascertained and the amount therefore known) gives this contractor a clear return of some Rs. 30,000 a year, independently of all his receipts for the tolls on the animals carrying the salt, and from the other traffic, which together must amount to as much more. It is easy to show in fact that minus the mere expense of collecting the tolls, the returns will give him over his contract rent at least Rs. 30,000 a year, and this without any risk.*

I entirely reject the idea that this contract was given to the present holder of it from interested motives, although such a statement was freely made in the district; but I am convinced that, in sanctioning such an agreement, the Government must have been in ignorance of the facts. It is clear, in any case, the matter demands re-investigation, and that the tolls require *re-adjustment,* and not merely *reduction.*

Wheeled carriage now comes up to the left bank of the Jhelum for this salt, and the superior economy of this mode of transport will lead to the steady increase in the number of carts so employed. It would be highly desirable that a *good cart road* should be made from Pind Dadun Khan to the mines at Keura, and thus facilitate this extension of a more economical transit.

The preceding remarks are intended to apply more particularly to the mines at Keura, near Pind Dadun Khan, from which by much the larger portion of the supply of salt is obtained, but to a large extent they are equally applicable to the others now open in the Salt-Range.

At Maree, opposite Kalabagh on the Indus, salt is quarried, not mined, being cut from the open face of the rock salt, which forms the whole side of the hill. The mode of working is capable of great improvement. Indeed, it can scarcely be expected that the poor miners, who receive only three rupees twelve annas for each hundred maunds, can afford to open out properly, or to excavate on any general system, the salt rock. There is a heavy covering of clay and pebbles, some feet in thickness, which has all to be removed at the expense of the miners before they can get out the salt. Galleries or mines have been commenced here, but were only a few feet in when I was there. I doubt the expediency of the change at this locality. The workings at Kalabagh on the opposite side of the Indus have been closed.

The great want here, as at Keura, is the want of a little power on the part of the officer in charge to spend small sums in cases of urgency for the improvement of the mines. It is not fair to expect the miners to do these things.

WASTE.—Here, as at all the mines, the amount of salt wasted is very large, and the consequent loss is very considerable. This occurs in more ways than one. First, salt which falls from the roof and sides of the galleries is frequently left lying on the floor, and then becomes trodden and dirty, and useless, whereas, if removed at first, it is quite as good as any other. In many cases, this amounts to a considerable proportion. Further, all the small salt which necessarily results from

* I am indebted to Mr. Login, late Executive Engineer at Pind Dadun Khan, and to Mr. Wright, the Collector of Customs, for the above numbers.

the processes of cutting, blasting, &c., is left to be destroyed, and when the larger lumps are brought to the pit's mouth with great labor and fatigue, the buyers are not satisfied to take these lumps as they are brought out by the miners, but invariably trim them in a rude way, using stones as hammers, into nicely rounded lumps of a portable size and form ; all the smaller pieces are rejected, and all the small salt, which they produce by so trimming these blocks, is left on the ground to be trodden on and wasted.

I estimated on the spot at several places that the amount of salt wasted was on the average one-tenth of the whole amount removed ! !

Nor is this immense quantity only wasted as salt. It impregnates all the waters of drainage thoroughly with salt, and these waters then become highly injurious to all the lands to which they reach.

The quantity thus lost is in several cases more than the whole amount annually obtained from some of the largest salt mines in Europe, and even a single stream in some cases, if properly economised, would there make the fortune of many a salt proprietor.

Perhaps, when the heavy tax of six shillings per maund (80 lbs.) very nearly one penny per lb. is demanded, it may be said that the buyer is justified in taking only the very best salt, and taking this only in the most portable and durable form. But could not the inferior salt be sold at a lower rate ? I am aware that I was always told that the purchasers *would not* take this small salt, but the slightest enquiry showed that this was simply because they could for the same rate obtain the large lumps which were more portable and durable, but that were a reduction made in the price of the inferior salt, a very large portion of it would be willingly taken. I cannot venture to decide how far such a system would be desirable. I am unable to see any practical difficulty in the matter. And I confess it is painful to see so valuable a mineral not only going to waste, but becoming absolutely and largely and widely injurious.

This waste is still greater and more melancholy in the extensive mines of Kohat district. It is perhaps wrong to call these mines at all, for there is not a single under-ground working in the whole district, all being open quarries, occasionally, but rarely, slightly under-cut. In this Trans-Indus district the tax levied is very small as compared with the Cis-Indus salt, varying at different mines from four annas to two annas per maund, and never therefore exceeding one-twelfth part of the impost levied in the Cis-Indus. Although the wastage therefore in this district is more than double what it is in the Cis-Indus mines, the actual money value (at present rate) of this loss is greatly less. Still in the aggregate it is a considerable loss. The greater portion of the salt from the Kohat mines is also carried long distances to the west into Cabul and all the adjoining countries, over wild and rough roads and passes, and it is, therefore, more important for the dealers to have their salt in as portable and desirable a form as may be practicable. All the salt here also

is carried away in open nets made chiefly from the leaves of the small dwarf-palm so common in this district, and for which it is essential to have larger lumps, whereas in the Pind Dadun Khan district, and in the Salt-Range generally, it is almost all carried away in close bags, made of camel's hair. This latter material is however just as plenty in one place as the other, and the sale of the small salt at a lower rate than the larger lumps would, I think, soon lead to its adoption.

In many of the workings in Kohat, the heaps of rubbish turned over in the progress of quarrying and to clear the salt from the clay, &c., which rests on it, were found to be made up of fully *one-half* salt chiefly in lumps, many of which were six to nine inches across, with smaller ones. Many hundreds of tons of salt are thus annually wasted or worse than wasted.

In the working of these valuable Kohat mines no system whatever is adopted ; the miners are allowed to cut the salt wherever (within certain limits) and however they please. The buyers go to the mines, agree with the workmen for the salt they require, load their camels or bullocks, and then proceed to the weighing house, often some miles away, and there pay the tax or toll on what they have taken.

The salt, though mostly of a different tint of color, is quite as good as that of the Cis-Indus rocks.

It is not for me to enter into any consideration of the political reasons which may have led (and I have no doubt justly) to the vast difference in the amount of the customs duty levied in the two districts. But I am compelled very strongly to urge that the present wasteful and costly mode of working these valuable deposits is deserving of very careful re-investigation.

If the government of the country continue to be, as they are now, the sellers of the salt, I think they ought in all cases to sell direct to the buyers, and to allow of no intermediate bargaining with the miners (whose right of property in the salt is entirely denied). If, on the other hand, the buyers are allowed to purchase from the miners, it would be better to allow them to make what bargains they could, and not to interfere by attempting to regulate the price, reserving the Government interference solely to the collecting of the authorised customs duty on the salt as it was carried away.

There would be much less waste in this latter way, the interest of the miner or seller would compel him to see that his salt lumps were as little broken up as possible ; the interest of the merchant or buyer would be to get his salt at the lowest rate, and he would be willing to fill up the packages with the small salt at a reduced rate.

At the present the Government appear to me to be in the anomalous position that they work the mines and yet do not work the mines : that they sell the salt and yet do not sell the salt (for others get the money) ; and that they levy or collect the tax, and yet allow other taxes to be imposed also.

I do not consider it necessary to enter here on any details of organization. I am satisfied the Collector of Customs, in communication with any Mining Engineer, would be able rapidly to establish such a system in detail, as would obviate all the existing objections, and bring the whole into good working order.

To simplify the arrangements for preventing trespass and unauthorised removal of salt, a plan proposed by Mr. Login, lately Executive Engineer at Pind Dadun Khan, of making a road right round each salt 'rukh' or mining area, seems very deserving of attention. The preventive duties of the Salt Department might then be limited to all within this encircling road, and the boundaries would thus be far more effectively and simply marked out than they can be by imaginary lines drawn from pillar to pillar placed at considerable intervals.

WATER.—Sweet water is in the salt-country one of the most important considerations, and very much remains still to be done to improve and economise its supply. Under Mr. Purdon's able direction, a very simple but very effective plan of carrying out the sweet waters of the hill stream into the plains to the south, by taking off the supply above those parts of the stream course where the salt-marls are exposed, and carrying this sweet water in open troughs, has proved of immense service to the country between Pind Dadun Khan and Keura, and has enabled the trade in salt to be more than doubled. There are many other places where a similar arrangement could be adopted with marked advantage and at trifling cost. There are also many other cases where the water issuing from the hills, though not salt, becomes rapidly absorbed in the deep gravel talus which flanks the hills, and is so lost to the country beyond. In these cases, a similar plan of carrying the water in a water-tight trough over the absorbing beds out to the plains beyond would be of incalculable value. The great want of this district is water, and yet nothing whatever (excepting by Mr. Purdon at Keura) has been done to economise and utilize what little supply there is. A plan similar to that I speak of has been largely adopted at the foot of the Kumaon Hills and elsewhere, and has there changed the face of a large tract of country from an arid, uninhabitable waste to widespread cultivation.

PETROLEUM OR MINERAL TAR.—At the request of the Honorable the Lieutenant Governor I also visited more than one locality within the Salt-Range and in the Kohat district where this earth-oil is known to exude. In all cases it is brought to the surface in springs of water highly charged with sulphuretted hydrogen. The petroleum or asphalte (for it is more truly an asphalte) floats at first in detached globules on the surface of the water; these aggregate, and a coating of the oily matter is formed. The supply in all cases in these districts is extremely limited, and it takes months to accumulate even a maund or two. This earth-oil is at present used almost solely for medicinal purposes, as an application for sore backs, &c., in camels, bullocks, &c., or when these animals are afflicted with cutaneous diseases (mangy, &c.). The sulphureous water, which accompanies the petroleum, is also administered internally with the same medicinal object.

I see no prospect whatever of any such extension of these springs as would render this product commercially valuable. Some little improvements might be made in the mode of collecting the mineral. At present it is collected in the rudest way. A heap of straw or grass is put into the petroleum, and turned about; it is then removed, and the adhering oil is roughly scraped off into a ghurrah by passing the hand tightly over the straw.

After careful examination, I did not see anything to justify much expenditure in attempting to open out pits or wells with a view to increasing the supply. It can never be, I think, more than locally and limitedly useable.

Small deposits of sulphur are invariably found accompanying these sulphureous springs, and these yield a limited supply of this mineral to the Natives; the amount obtained could be inconsiderably increased if there were any demand.

Reported to the Right Honorable the Secretary of State for India, in letter No. 101, dated 3rd June 1867.

Memorandum by MR. FRED. CHAS. DANVERS, *on Indian Coal, with reference to their employment as fuel for Indian Railways and Steamers,—Dated India Office, London,* 19*th November* 1867.

Dr. Oldham's very valuable paper on "the Coal Resources and Production of India," dated in March last, furnishes, amongst other information, a statement of analyses made at various times upon 80 different varieties of Indian coal, obtained from the principal coal fields throughout India. The results shown by direct assay of the mineral cannot, of course, be accepted in all cases as conclusive, but in the absence of more reliable information derived from the practical use of the coal, they may be fairly accepted as approximately true.

In the above-mentioned report, we are informed that the average composition, as determined from 74 assays of Indian coal is as follows:—Fixed carbon 52·2, volatile matter 31·9, ash 15·5. And the results of similar assays of five specimens of English coals, such as were saleable in the Calcutta market during the last three years, showed an average composition, of fixed carbon 68·10, volatile matter 29·20, and ash 2·70.

The relative duty or effective power of coals may be taken to vary directly as the amount of fixed carbon they contain; and, says Dr. Oldham, "taking this test it will be seen that out of the whole series of Indian coals only one or two come up to this average, or, in other words, that the *very best coal of Indian fields only touches the average of English coals.* If, on the other hand, we take the relative amount of ash matter, which does not contribute to the heating power of the coals, we find that the average of Indian coals shows no less than 15½ per cent. as against less than 2¾ per cent. in English coals.

"Practical trials on a large scale show the same result. The two most heavily worked lines of railway in India, namely, the East Indian and the Great Indian Peninsula, use, respectively, Indian and English coal. And their relative consumption is 150 tons per mile in the former as compared with 75 tons in the latter. It is, therefore, certain that Indian coals are not capable of more than two-thirds, in most cases not more than one-half, the duty of English coals.

"The relative amount of ash will also materially affect the cost of carriage. If that amount be on the average 15·5 per cent., it is obvious that in every ton of coal carried, more than one-sixth of useless material is also carried. And this becomes a very important element when space or stowage is concerned."

The experience obtained by the British India Steam Navigation Company relative to the use of Indian coal in sea-going steamers, is, that, generally speaking, about one-half more is required of Indian than of good English coal to produce a given heat. It also forms a slag which blocks up the bars and prevents ventilation; and the ash and clinker turned out being about 50 per cent. greater than results from the use of English coal, the staff of firemen and coal trimmers has to be increased in a corresponding ratio. Rubble coal alone is used for steamers. Small coal will scarcely burn, being so earthy and impure.

The foregoing shows what a considerable amount of impurities is contained in Indian coals. These impurities consist chiefly of earthy matter, mechanically combining with the carbon, and, therefore, capable of being mechanically separated from it. So far as I am able to judge from the particulars contained in Dr. Oldham's report, and from further information on the subject which I obtained from Dr. Oldham himself just before his recent departure for India, there would appear to be no difficulties, by the employment of well known expedients, in obtaining from the Indian coal fields a fuel nearly as pure as, and at a much less cost than, English coals, for use on the railways and steamers in India.

The practice of coal washing, though extensively adopted in France, Belgium, and some parts of Germany, is only just now beginning to be generally introduced by the various coal owners in this country. Several years ago a Bourdon's coal-washing machine was brought over to this country, but it was only employed by the person who introduced it. The patent has now expired, and coal proprietors, having seen the advantages to be obtained by its use, are now beginning to adopt it. Coal washing is already extensively practised at the Ebbw Vale Ironworks for the small stuff which was formerly lost, and this makes such excellent coke that it is used in the furnaces for making Bessemer steel. Another of these machines has also recently been started at Dowlais. The following is a description of the one at Ebbw Vale, taken from "Engineering :"—

"The fine coal is raised by a Jacob's ladder to the top of the washing tanks, and led by separate spouts into each of the four compartments. These are of cast iron, about four feet square, open at the top, and hopper bottomed to permit the escape of the slate and heavier matters. The compartments are kept nearly full of water, which is churned up and down through the coal by means of four 30-inch pistons, working with a 4-inch stroke, in as many open topped cylinders at the side, one piston to each compartment. The shale, pyrites, &c , soon settle to the bottom by their greater weight, and are let off at intervals by opening a valve, some of the water escaping and more being then added. One combined machine with four pistons and washing tanks, is worked by a small engine, and is attended to by two men and six girls. It will wash 200 tons in 12 hours, at a cost of less than 8*d.* per ton, all told, the wages amounting to hardly 15*s.* a day. What was once wasted is thus converted, when coked, into most valuable fuel, the coke from washed coal slack being purer than that from the large coal of the same pits, inasmuch as most, if not all, the sulphur is washed away."

In order to apply this washing to Indian coals generally so as to render them nearly equal in purity to English coals, it would be necessary, in the first instance, that they should all be reduced to the consistency of coal slack by being broken very small, the smaller the better. After washing, it would by no means of necessity follow that all the coal should be converted into coke, but it would be a great advantage if all intended for use by locomotives or steam vessels were so treated, as they would thus be enabled to burn the purest form of

carbon obtainable for their purposes. That portion, however, which it might be desired to keep in the form of coal should be converted into what is generally known by the name of "artificial fuel;" that is, the small coal should be compressed again into blocks, the particles being made to adhere by the employment of a very small percentage of gluten, tar, or other suitable cement. The best material hitherto used for this purpose is an organic substance obtained as a residue in the manufacture of starch, and which is almost valueless for other purposes. This can be employed in quantities not exceeding one per cent. of that of the coal dust to be compressed with it; it leaves no ash in burning, and what is still more important as compared with the ready liquidity of coal tar, it does not melt at a high temperature, so that its binding effect is not lessened when exposed to the heat of the fire.

I saw a great many specimens of this artificial fuel in the Paris Exhibition, and many of them seemed to be of excellent quality, the fracture presenting an appearance somewhat resembling the fracture of pig iron, only with a coarser grain. The particles when pressed and rubbed hard with the hand did not easily separate, and little or no dust was made by it, even under rough usage. The character and qualities of these kinds of compressed fuel depend upon the nature of the original coal from which they are produced. The Belgian coal, and that of St. Etienne, which always requires washing on account of the pyrites and other impurities which it contains, must go through this process before being compressed; the coal from screenings and dust from Ostrau, on the other hand, is so pure as to require only cementing together to make an excellent fuel. M. Felix Dehaynin, of Paris, states that his machine (which is a modification of one by M. Evrard, the Engineer of the Compagnie Anonyme des Huilieres de la Chazotte, near St. Etienne), produces 10 tons of fuel per hour, with a motive power of 80 horses. The whole machine weighs about 65 tons, with all its accessories and gearing, including the steam-engine. The coal bricks are slightly heavier than natural coal, and their calorific effect has been found fully equal, and in some cases even superior, to the latter. The process of washing removes about 5 per cent. of the weight of the coal dust, representing incombustible impurities, and the compressed fuel leaves only six to seven per cent. of ashes. The compressed fuel of Chazotte leaves only four or five per cent. of ashes. This latter is made from anthracite coal containing 81 per cent. of carbon, 16·5 per cent. of hydrocarbon, and 2·5 per cent. of ashes. Some experiments made by the Messageries Impériales, and by other parties, have shown a superiority of this fuel over the best coal from Cardiff, amounting to 10 per cent., weight for weight. The Northern Railway of Austria has a production of 15,000 tons per annum. The *briquettes* used on that line evaporate 7·1 to 7·2 pounds of water per pound of fuel in regular practice with locomotives for passenger trains, in which this fuel is used in preference to coal. The prime cost, taking the coal dust at its selling price at the pit's mouth, is stated to be considerably below that of the solid coal drawn from the same pits.

In England the Patent Fuel Company manufacture a somewhat similar material upon the principle known as Warlich's patent. This

fuel is made from the best Welsh steam coal, and is made into bricks by machinery, which exerts a pressure of three tons to the square inch. These bricks are afterwards baked in retorts up to a heat of from 700 to 800° fahrenheit, which has the effect of removing any sulphur which might previously have existed in the coal, together with a large percentage of the water contained in it. The cement used is principally pitch, with a small proportion of tar. In the report on experiments made with various kinds of coal in Portsmouth Dockyard in April 1858, one pound of this fuel is stated to have evaporated 9·23 pounds of water, and the residuum, after combustion, was found to consist of 1·88 ash, and 1·68 clinker, or a total of 3·56 per cent. of ash and clinker combined.

The East Indian Railway carried down to Calcutta during the year 1865 6,279,207 maunds of coal. This was probably chiefly drawn from the Ranigunge coal-field. The mineral from that district contains from 8·50 to 35·20 per cent. of ash, the average on 30 specimens referred to in Dr. Oldham's report being 15·59 per cent.; so that, of the above-mentioned quantity of coal conveyed by the East Indian Railway Company, it is not unreasonable to suppose that 9,78,927, or nearly one million maunds, consisted of unserviceable ash. The cost of conveying this amount of rubbish a distance of 121 miles, at the rate of $1\frac{1}{4}d.$ per ton per mile, must have exceeded 22,000*l.* !

Supposing this coal to have been first freed from its impurities in the manner above referred to, so that on leaving the mines it contained only from five to six per cent. of ash, a saving in carriage alone would have been effected amounting to nearly 15,000*l.*, equal to 1*s.* 4*d.* a ton on the whole amount brought down by the railway; and judging from what has already been stated regarding the cost of similar operations in Europe, this would probably be an ample margin to allow for washing and converting the coal either into coke or artificial fuel, and thus a far purer fuel might be set down at Calcutta (worth considerably more than 1*s.* 4*d.* a ton beyond the value of the coal as it is in its natural state) by railway from the Ranigunge coal-fields for the same price at which an immensely inferior article is now obtainable there.

The high price in India of coal exported from England, averaging for the last two years on its arrival about 2*l.* 10*s.* per ton, is a subject for very serious consideration. The impurities contained in the Indian coal now employed by some of the railways must act as a serious drawback to the economical working of those lines, not only on account of the bulk of useless matter contained in the fuel, but also in consequence of the injurious effect those impurities which they largely consist of have upon the locomotives themselves, by the formation of clinker, which also necessarily entails much additional labour for its removal.

The supply of Indian Railways with good and cheap fuel is a subject of as great importance to the Government as it is to the Railway Companies themselves, since cheap and good fuel leads to economy in one branch—and that by no means an unimportant one—of the working expenses of a line. It is impossible for bad fuel to be absolutely cheap, although under certain conditions it may be relatively so when compared with the cost of coal sent out from England, for its use is necessarily attended with many and serious drawbacks, all leading to

expenses which would not be required where good coal only was employed, and which thus make the low priced inferior article absolutely the more expensive in the long run.

MINING STATISTICS, &c.

Extract from the Proceedings of the Government of India, Public Works Department,—No. 359*R, dated* 23*rd April* 1867.

Read again—

Public Works Department No. 52R, dated 17th January 1867.

Read also—

Home Department No. 3075, dated 25th March 1867, with enclosures.

OBSERVATIONS.—With this letter is forwarded a memorandum on the coal resources and products of India by the Superintendent of the Geological Survey, together with copy of a correspondence on the subject. Dr. Oldham, in his letter No. 470, dated 3rd June 1866, and again in No. 557, dated 26th January 1867, remarked on the absence of reliable information on the subject of the production of coal in India, and the out-turn of the various collieries now being worked, and expressed an opinion that investigations should be carried out, and statistics compiled, in order to keep information of the kind up to date, and to the level of the advance of the knowledge of the geological structure of India.

2. In support of this view, it was urged that it was merely necessary to detach a single Assistant of the Geological Survey, who should devote his whole time to the duties of receiving returns from the managers and proprietors of mines, and facilitating the supply by them of information by personal communication, and also by ascertaining by personal enquiry the amount of the produce of the various mines.

3. The expense of the proposal would, therefore, be limited to the salary of one Assistant on the Survey and his travelling expenses.

4. This proposal was, when first made, negatived in the Home Department, it being thought that the information to be acquired would not be worth the expenditure involved.

5. The correspondence is now forwarded to the Public Works Department, with a remark that the question will not be re-opened unless it be considered desirable in that department.

6. The Governor General in Council in this department fully concurs in the force of the remarks made by Dr. Oldham in the 3rd paragraph of his letter, dated 3rd June last, and is strongly of opinion that it is better that these matters should be started on a proper basis while mining is yet in its infancy in the country, even though it may be doubtful whether the information obtained at first will in itself be of great importance.

7. A great deal will have been gained if a regular and systematic record of mining operations is obtained before these operations have extended further than they now do.

8. In this view His Excellency in Council in this department considers that the suggestion of Dr. Oldham might with advantage be carried out, and desires that the question should be re-considered in the Home Department.

ORDER.—Ordered, that these observations be communicated to the Home Department for information and further consideration.

From E. C. BAYLEY, ESQ., *Secretary to the Government of India Home Department, to Officiating Superintendent of the Geological Survey of India,—No.* 621, *dated Simla,* 27*th May* 1867.

Public Works Department, No. 52R, dated 17th January 1867.
Home Department, No. 3075, dated 26th March 1867.
Public Works Department, No. 359R, dated 23rd April 1867.

Referring to the letter from this department No. 2451, dated the 3rd of July last, to the address of Dr. Oldham, I am directed to forward the accompanying copy of the resolutions marginally noted, and to observe, with reference to the reasons adduced by the Public Works Department, that no time should be lost in organizing some proper system of obtaining correct mineral statistics. In this view I am directed to request that you will submit a detailed scheme, with a tabular statement of the proposed establishment and contingent expenses.

From H. B. MEDLICOTT, ESQ., *Officiating Superintendent of the Geological Survey of India, to Secretary to the Government of India Home Department, Simla,* —*No.* 646, *dated* 12*th June* 1867.

I have the honor to reply to your letter No. 621 of 27th May 1867, conveying instruction regarding an estimate for the regular collection of correct mineral statistics for India.

2. In recommending, on various occasions, the systematic observation and registration of mining statistics, Dr. Oldham has already, in a general way, indicated the measures he would propose; I entirely concur in the suggestions urged by Dr. Oldham, and I will endeavor to put them in a more detailed form. The fitness, I might say the necessity, of having this work affiliated to the Geological Survey of the country is too obvious to be further commented upon; I will therefore take for my guide the rates of pay at present sanctioned for the Survey, as if for an addition to its staff. It would no doubt be desirable that the system should be initiated by some one already well acquainted with the coal rocks of India; but it would most seriously cripple the progress of the Survey to have one of its best officers permanently detached on such a special duty, and perhaps the object here indicated would be best attained by the immediate supervision Dr. Oldham would himself exercise upon the commencement of the project.

3. The work would at present only involve the services of one qualified officer with a small office establishment. The knowledge and experience required in the man entrusted with this duty (see this Office

letter, No. 470 of 6th June 1866, to your address) could not be obtained at a less rate of remuneration than that now sanctioned for the grade of Assistant Geologist, the 2nd grade on the staff of the Geological Survey and with a prospect of rising to the 1st grade. Allowances should also be granted at the same rate as to the other officers of the Survey.

4. The duties of such a post would entail more frequent and rapid travelling than is necessary for the regular field work of the Survey, and, consequently, the expenditure under this head would be heavier in the case of the Mining Geologist. It would appear in the usual way Rs. 4 or 5 per day while out on duty, or as railway or other fare bills, or as mileage. I should think that a sanction of Rs. 150 per month all the year round would quite meet charges for travelling.

5. One intelligent clerk would probably be sufficient for the office work at the commencement. I should expect that Rs. 50 per month would pay this clerk and meet all necessary office expenses. This estimate like the last would be checked by the actual items.

6. For field establishment I have taken the sum allowed on the Survey, Rs. 25 per month.

7. I do not consider that there need at first be any contingent expenses.

8. The total annual expenditure thus incurred would be as shown in the annexed abstract :—

	Monthly charges.	Annual charges.
	Rs.	Rs.
One Mining Geologist, salary commencing at Rs. 500, not to exceed Rs. 1,000 a month, rising by Rs. 50 each year ...	500 to 1,000	6,000 to 12,000
Allowances	130	1,560
Field Establishment	25	300
Office "	50	600
Travelling charges	150	1,800
TOTAL ...	855 to 1,355	10,260 to 16,260

9. The primary business of this office will be the collection and tabulation of the mineral produce of India, as done in the Mining Record Office in England and in other European countries, and of which an approximate idea may be formed upon the returns recently sent in by Dr. Oldham. It would also be the duty of the Mining Geologist to examine the pits with a view to improving the system of working; and to make a special study of the mineral deposits, with a view to the extension of the mining operations, and to the more precise determination of

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9. The primary business of this office will be the collection and tabulation of the mineral produce of India, as done in the Mining Record Office in England and in other European countries, and of which an approximate idea may be formed upon the returns recently sent in by Dr. Oldham. It would also be the duty of the Mining Geologist to examine the pits with a view to improving the system of working; and to make a special study of the mineral deposits, with a view to the extension of the mining operations, and to the more precise determination of

the resources of the field. In fact, he would attempt for India what is accomplished in England by the local Inspectors of Mines; by Mr. Warrington Smyth, the Mining Geologist to the Geological Survey of Great Britain; and by Mr. Robert Hunt, Keeper of the Mining Records. It will not be supposed that such a post can be a sinecure, or that the work, if fairly accomplished, can be unproductive.

10. I will at once communicate to Dr. Oldham the proposal that has now been made that he may make enquiries, for a man fit for the duties in question, and I would solicit early information of any decision on the part of Government.

No. 2629, dated Simla, 23rd July 1867.

Forwarded to the Financial Department, with the papers noted in the margin, for consideration and orders, especially with reference to the cost of the proposed scheme compared with the usual scale of pay for Assistants on the Geological Survey; and the return of the papers requested.

From Superintendent Geological Survey, No. 470, dated 3rd June 1866.
To " " " 2451, " 3rd July "
From Public Works Department, No. 52R, dated 17th January 1867, and enclosures.
From Superintendent Geological Survey, No. 557, dated 26th January 1867, and enclosure.
Resolution No. 3075, dated 26th March 1867.
From Public Works Department, No. 359R, dated 23rd April 1867.
To Officiating Superintendent Geological Survey, No. 621, dated 27th May.

Office memo. by E. H. Lushington, Esq., *Secretary to the Government of India Financial Department, No.* 1796, *dated Simla, 2nd August* 1867.

With reference to docket No. 2629, dated 23rd July 1867, the undersigned has the honor to inform the Home Department, that the proposal for the appointment of a Mining Geologist, at an annual expense, for salary and establishment, of Rs. 10,260, rising to Rs. 16,260, has been referred to the Secretary of State, with a request that, in the event of his according sanction, Dr. Oldham, who is in England, may be informed.

2. The original papers received with the above-mentioned docket are herewith returned; copies having been kept for record.

No. 4744, dated Simla, 21st September 1867.

Endorsed by the Home Department.

Copy forwarded for information to the Officiating Superintendent of the Geological Survey of India, with reference to his letter No. 646, dated 12th June.

Extract from the Proceedings of the Government of India in the Financial Department,—No. 199, *dated* 14*th January* 1868.

Read the following despatch :—

From the Right Hon'ble Sir Stafford H. Northcote, Bart., *Secretary of State for India, to His Excellency the Right Hon'ble the Governor General of India in Council,—No.* 158, *dated India Office, London,* 23*rd November* 1867.

The despatch of your Excellency in Council in the Financial Department, dated 2nd August, No. 181 of 1867, forwarding some papers relative to the proposed appointment of the Mining Geologist, at an annual charge for salary and establishment of Rs. 10,260, rising to Rs. 16,620, has been considered by me in Council.

2. In reply, I have to express my approval of the proposed arrangements, and will request Sir Roderick Murchison, Dr. Oldham having returned to India, to select a competent person for the post.

Order.—Ordered, that a copy of the above be furnished to the Home Department, with reference to Office memorandum from this department, dated 2nd August 1867, No. 1796, and also to the Comptroller General of Accounts.

Nos. 326 and 327, dated 24th January 1868.
Endorsed by the Home Department.

Copy forwarded to the Superintendent Geological Survey of India, in continuation of endorsement No 4744, dated 21st September last; and to the Public Works Department, with reference to its No. 889, dated 30th ultimo.

From the Right Hon'ble Sir Stafford H. Northcote, Bart., *Secretary of State for India, to His Excellency the Right Hon'ble the Governor General of India in Council,—No.* 19, *dated* 31*st January* 1868.

In continuation of my despatch of the 23rd of November last, No. 158, I have to inform your Excellency in Council that I communicated your letter, in the Financial Department (Education, Science and Art), dated the 7th of August 1867, No. 181, and its enclosures, to the Director of the Royal School of Mines, and requested him to select a competent person for the post of Mining Geologist in India.

2. Sir Roderick Murchison, in a letter dated the 16th ultimo, of which I enclose a copy for your information, recommended Mr. Mark Fryar to fill the appointment, and I have accordingly nominated that gentleman to the post in question,—the terms of his engagement being set forth in two letters to his address, dated, respectively, the 6th and 24th instant, a copy of which I also forward for the information and guidance of your Excellency in Council.

3. Mr. Fryar will reach Calcutta on or about the 22nd of April next.

From Sir R. E. Murchison, *to* Lord Clinton, &c., &c.,—*Dated Geological Survey Office, Jermyn Street, 16th December* 1867.

In consequence of the request conveyed to me, by the direction of Sir Stafford Northcote, in your letter of the 20th November, I have taken due pains to select a competent person to carry out efficiently the duties of a Mining Geologist on the Geological Survey of India.

The gentleman who, after much enquiry, I recommend for this new post is Mr. Mark Fryar, a practical Mining Engineer, now resident at Hanham, near Bristol.

Mr. Fryar was in early life engaged in colliery operations in the north of England, and has been recommended by Lord Ravensworth and the Hon'ble Augustus Liddell as a proper person to be one of Her Majesty's Inspectors of Mines.

He has since been employed to inspect and report upon the copper and iron mines in Servia, and to inspect the petroleum springs on the flanks of the Carpathian Mountains. He has also been engaged, by order of the Viceroy of Egypt, in surveys in Ancient Thessaly, Syria, South Arabia, and the West Coast of Africa, and has reported upon the mineral produce of those tracts.

I find that Mr. Mark Fryar will accept the appointment in question on the terms offered; but, having a wife and three children, he wishes to know if the Indian Government would, besides his own passage, pay anything towards the passage of his family to India.

P. S.—The official documents accompanying your despatch are retained for a short time, in order that Mr. Fryar may become acquainted with their contents.

I may add that Mr. Fryar is in the prime of life, or between 30 and 34 years of age.

From H. Merivale, Esq., c. b., *Under-Secretary of State for India, to* M. Fryar, Esq.,—*Dated India Office, London, 6th January* 1868.

The Director of the Royal School of Mines having recommended you for the post of Mining Geologist on the Geological Survey of India, I am directed to inform you that the Secretary of State for India in Council is pleased to nominate you to that appointment. Sir Roderick Murchison communicates your enquiry whether anything would be paid by Government towards the passage of your family to India. In reply, I am to inform you that it is not the practice of the Indian Department to grant allowances for this purpose, but that the usual sum, £150, will be paid to you on account of your outfit and journey to India. You will take your departure for Calcutta at any time within three months from the present date. Your salary will date from the day of your reporting your arrival at Calcutta to the Government of India, commencing at the rate of Rs. 500 per mensem, and rising by *Rs.* 600* each year to Rs. 1,000 per mensem. Your travelling expenses will be paid by Government, and you will have a small field and office establishment.

* *Note.*—The letter sent to Mr. Fryar by mistake said 50, he was requested by the 9th instant to alter it to 600.

Sir Roderick Murchison has doubtless made you acquainted with the duties attaching to the appointment which you are about to hold; they are, speaking generally, as follows:—To collect and tabulate the mineral statistics of India; to examine the coal pits, with a view to improving the system of working; and to make a special study of the mineral deposits, for the purpose of extending mining operations and determining more precisely the resources of the field.

From J. Cosmo Melvill, Esq., *Assistant Under-Secretary of State for India, to* M. Fryar, Esq., *dated India Office, London, 24th January* 1868.

I am directed, &c., to acknowledge the receipt of your letter of the 10th instant, relating to the salary and allowances attaching to the post of Mining Geologist in India, to which you have been appointed.

In reply, I am to inform you that your understanding as to the rate at which your salary will increase is correct, namely, by Rupees 50 per mensem from the commencement of the second year of your appointment, until it shall reach Rupees 1,000 per mensem.

As regards the allowances of Rupees 130 a month, to which you advert, and the travelling allowances of Rupees 150 per mensem, it is not quite clear, from the correspondence forwarded by the Government of India, whether they are to be disbursed to yourself alone, or to be shared by the establishment which will be allowed to you. It will be left to the Indian Government to arrange the details as to the allowances in question.

I am to add that, on your arrival at Calcutta, you should report yourself to the Secretary to the Government of India, in the Financial Department (Education, Science and Art).

Nos. 1311-13, dated 12th March 1868.
Endorsed by the Home Department.

Copy forwarded to the Financial Department, Superintendent Geological Survey, and Public Works Department in continuation of endorsement No. ——, dated 24th January 1868.

GEOLOGICAL TOUR OF DRS. OLDHAM AND STOLICZKA, AND ITS RESULTS.

From the Right Hon'ble the Governor General of India in Council, to the Right Hon'ble Viscount Cranborne, Secretary of State for India,—No. 54, *dated* 26*th March* 1867.

Under the circumstances explained in the accompanying copy of a communication* from the Superintendent of the Geological Survey of India, we have sanctioned his proposal to proceed to Europe, accompanied by his Assistant, Dr. Stoliczka, on duty connected with the Geological Survey, for a period of six months. The arrangement, you will perceive, entails no extra expense upon the State.

* No. 589, dated 13th March 1867.

From T. OLDHAM, ESQ., LL. D., *Superintendent of the Geological Survey of India, to the Secretary to the Government of India* HOME DEPARTMENT,—*No.* 589, *dated* 13*th March* 1867.

One of the most serious difficulties which the Geological Survey has had to contend with in this country has ever been the want of standard collections for comparison and reference. Since the establishment of the Geological Museum much has been done to remedy this evil. But there still remain, of course, many gaps in our series. At the present time, in immediate connection with the description of the Indian cretaceous gastropoda, we are greatly hampered by the want of such, and in fact we cannot bring out *satisfactorily* the papers of the Survey due at the end of the year without comparison of some of our Indian specimens with standard collections in Europe, containing unique series which cannot, at any cost, be obtained for this country. To do full justice to this investigation, it would be essential to visit the collections now preserved at Vienna, Turin, Geneva, Caen (Normandy), Munich, London, Moscow, and possibly St. Petersburgh. *This must be done sooner or later*, and it is highly desirable it should be done at once.

It is obvious that such an examination and comparison cannot be made without serious and heavy cost, though, if it be practicable in any way, it ought to be accomplished. In discussing, therefore, the matter fully with Dr. Stoliczka, our Palæontologist, I have ascertained that he, as well as myself, is so anxious to be able to compare these European collections, that he would be willing to proceed to Europe for the purpose, at his own expense, provided only his doing so be considered "on duty," and that he be permitted to be absent on this duty for six months. I think this a proposal very greatly for the advantage of the Geological Survey and of the Government; and also a most liberal offer on the part of Dr. Stoliczka, whose low rate of pay will barely enable him to meet the necessary cost by expending a whole year's income during those six months. He would proceed in April, after the close of the present official year, and be back before the cold weather season would commence.

By the very zealous exertions of Dr. Stoliczka, I am able to announce that not only the one fasciculus of the Palæontologio Indica due on the 1st of April next, is ready, but the whole four fasciculi only due at each successive quarter, are complete, and the parts for the entire year can be issued on the first day of that year. And, further, such progress has been made in the succeeding parts, that (with the exception of the information now sought to be obtained by personal comparison of other collections without which it cannot be so complete), the entire volume for the year 1868-69 could be ready in three months' time. This is abundant proof of how thoroughly and efficiently Dr. Stoliczka has devoted himself to aid in the punctual preparation of these most valuable memoirs, and that the same zeal would distinguish his investigations in Europe.

I most earnestly solicit that the proposal be sanctioned by His Excellency in Council.

If alone, however, Dr. Stoliczka will not, in the short time stated, be able to accomplish all that is required; and we must either limit ourselves to only a very partial success, or give him assistance.

Shortly after the establishment of the Geological Museum, I was ordered to proceed to Europe on the same terms exactly as now proposed, and to take with me an Assistant. We then visited many of the larger collections at Home, established friendly relations of exchange with them, made known our wants here; and on our return brought back with us series of specimens and books which, in money value, were worth all that we spent. It has been chiefly owing to this visit also that our collections have since then been annually enriched with valuable books and rarer specimens, which could not be obtained in other ways. The trip cost the State nothing. It cost each of those who went fully a year's pay during the six months' trip, but the advantages derived have been very great and continuous. I would now seek permission to do the same to proceed on duty, but at my own expense, taking with me such series as are now awaiting personal comparison and examination. In this way Dr. Stoliczka, taking up more specially the fossils, could proceed to such collections as were needed for his purposes; while I would take the minerals, rocks, &c., and investigate these. By this division of labor where practicable, and by united exertions in other places, I would anticipate that we should be able to clear away much of the difficulties which now impede our progress. I would at the same time take the opportunity of bringing together illustrative series, showing the practical application of the minerals to the arts and manufactures,—series which will be needed the moment the completion of the new Museum building will enable them to be exhibited. I have tried, but I regret to say in vain, to make such illustrative series by the aid of others.

The alteration of the end of the financial year to the 31st of March will enable me to complete annual report, accounts, &c., before going, and yet to be back before the field work of next season shall commence. Mr. H. B. Medlicott, Deputy Superintendent for Bengal, would take charge of the Office here, while the absence on leave of several of the Assistants will reduce the amount of work to be attended to.

The duty proposed will not entail one penny additional cost on the State, but the advantages will be very great, and by no means confined to the present. And, on these grounds, I would solicit the sanction of His Excellency in Council to my being absent (with an Assistant) from India for six months on duty connected with the Geological Survey of India, on the condition that no additional expense be incurred in consequence.

I would add that neither I nor Dr. Stoliczka seek for leave or any cessation of work. Our object is to facilitate the progress of the Survey, and we are willing to do this at considerable cost to ourselves, seeing that the desired end *cannot* be attained, excepting by such personal examinations.

From W. E. Ward, Esq., *Officiating Under Secretary to the Government of India* Home Department, *to the Superintendent of the Geological Survey of India,* —*No.* 2946, *dated 22nd March* 1867.

In reply to your letter of the 13th instant, No. 589, I am directed to inform you that the Governor General in Council is pleased to sanction your proposal to proceed to Europe, accompanied by your Assistant Dr. Stoliczka, on duty connected with the Geological Survey; your absence to last for six months, and terminating before the beginning of the next field season.

2. This arrangement, it is understood, will entail no extra expense upon the State.

Reported to the Right Hon'ble the Secretary of State for India in letter No. 54 of 1867, dated 26th March.

From the Right Hon'ble Sir Stafford H. Northcote, Bart., *Secretary of State for India, to His Excellency the Right Hon'ble the Governor General of India in Council,*—*No.* 52, *dated 24th May* 1867.

The dispatch of Your Excellency in Council, dated 26th March, No. 54 of 1867, stating that you have permitted Dr. Oldham, the Superintendent of the Geological Survey of India, with his Assistant Dr. Stoliczka, to proceed to Europe for a period of six months on duty connected with the Survey, has been considered by me in Council.

2. In reply, I have to express my approval of these arrangements under the circumstances explained in Dr. Oldham's letter to your Secretary.

EXAMINATION OF STANDARD GEOLOGICAL COLLECTIONS IN EUROPE.

From T. Oldham, Esq., ll. d., *Superintendent of the Geological Survey of India, to the Secretary to the Government of India,*—*No.* 803, *dated 11th December* 1867.

I had the honor a few days since to report, for the information of His Excellency the Governor General in Council, my return to Calcutta, accompanied by Dr. Stoliczka, and my resumption of the duties of this Office.

I have now briefly to state the extent of our recent examination of standard European collections, and our comparison of these with the Indian series.

Proceeding to Europe by Trieste, we commenced this comparison at Gratz, where, with the friendly aid of Professor Peters, we went over all the valuable collections. Thence to Vienna, the noble collections in which city were, as usual, most freely and liberally opened to us. From all we received the most zealous co-operation, and from several very valuable contributions. Leaving some fossil series to be examined more in detail by Dr. Stoliczka during a second visit, we proceeded to Cracow, whence we examined the famous salt mines of Wieliczha. Thence to Breslau, where we received every aid from Professors F. Roemer and Goppert, whose labours in Palæontology are well known and very highly valued. At Drespen, Professor Geinitz

not only received us with the most marked and cordial friendliness, but himself accompanied us to the important sections in the neighbourhood, and facilitated our researches in every possible way. From Dresden we visited the long celebrated mining centre of Freyberge, and then passed on to Halle, where Professors Gisbil and Girard opened their collections to our study. At Leipzig we were fortunate enough to meet Professor Naumanne, whose researches are well known to all geologists. From Leipzig to Berlin, and its splendid museums and valuable collections. From Berlin to Magdeburg, thence to Brunswick and Hanover, to study the beautiful collections of De Witta. Then to the long celebrated University of Gottingen, and from that to Giessen. From Giessen to Cologne, and thence to Bonn, the classical series in which place occupied our careful attention for some days. Aachen, where the original series of cretaceous fossils described by Müller and by Deby are preserved, next engaged us; and from Aix la Chapelle we proceeded to Maestricht to study the highly interesting and very valuable collections of Bosquet and of Binkhorst Von Binkhorst. We also visited the sections in the neighbourhood (St. Peter's Mountain). From this we passed by Antwerp to London.

In London, at the Geological Society, is preserved the very valuable series of fossils from the districts of Trichinopoly, originally described by Professor E. Forbes. A careful study of this all-important collection being one of our chief objects, we devoted to it and the other collections in London some weeks, during which Dr. Stoliczka was engaged for many hours daily in going over the series individually and most carefully.

Leaving London we proceeded to study the collection and sections in the field in the classic ground of Normandy. From Caen to Paris, where we received valuable aid during our brief stay from Professors Marcou, Hebert and Daubree, and were enabled to compare their valuable collections with good results.

From Paris Dr. Stoliczka proceeded to Munich, Stuttgart, Salzburg, and again to Vienna to complete his work there. The Munich collections of fossils and minerals are rapidly becoming most valuable, and under the able management of Professor Zittel, will probably soon be the finest in Europe. They are also of high interest to the Indian Geologist, as containing a large number of the original collections of the Brothers Schlagintweit, all of which were carefully examined.

Meanwhile, I returned to London, to further arrangements for the purchase of a large collection of fossils, rocks, and minerals. When visiting Giessen, I found the extensive collections made by Professor V. Klipstein during nearly quarter of a century for sale; and thinking that this series would prove an invaluable acquisition for the Calcutta collections, and finding that, if not secured at an early date, it would probably pass to other hands, I did not hesitate, in order to avoid delay, to solicit sanction from the Right Honorable the Secretary of State for India in Council to treat for this series within certain limits. After a little time, and full consultation with other Geologists and Palæontologists, all of whom strongly supported my recommendation, sanction was granted—as I have already reported—to my endeavouring

to secure this valuable collection for India, at a price not exceeding (exclusive of cost of packing and transport) three thousand pounds; and I was directed, if purchased, personally to superintend the packing and depatch.

This sanction reached me on the 7th September, and on the 8th I started for Giessen, having meanwhile requested Dr. Stoliczka to join me there again. I devoted two days, *en route*, to the study of the collections at Brussels. At Giessen we both went over the whole series of Von Klipstein's collections in detail, each doing this separately, and without communication, and forming a separate estimate of the value. Finally comparing these two estimates, and finding that, with the most trifling differences, they essentially agreed, I succeeded, after some difficulty, in agreeing to purchase *all* for the sum of two thousand and four hundred pounds, being six hundred less than the full amount sanctioned.

This careful examination and valuing of the collections occupied some ten days, and we had still to have the whole packed and despatched.

Among the most remarkable portions of this collection were some entirely unique and very valuable fossils, long known to Palæontologists, and long classical in the history of geology in Europe. Among others, especially the only known skull of the dinotherium and of the dorcatherium. These the Right Honorable the Secretary of State had suggested (and I entirely coincided in the suggestion) should be placed in safe keeping in some of the larger collections of Great Britain, where they would be freely accessible to the public, while our Indian collections should receive the equivalent value in money or exchange of specimens and costs of the originals.

My first care, therefore, was to see these unique specimens packed up and despatched to London, allowing time for their transport. I paid a rapid visit to the Museums of Darmstadt, Basel, and Bern, and hurried to London, and finally arranged to hand over the unique specimens to the British Museum, receiving for them the value.

Meanwhile, the packing of the remainder of the collection progressed under Dr. Stoliczka's personal superintendence, who during this time visited the collections at Wurzburg, Hidelberg, Frankfort, Wiesbaden, &c., the last box was closed at Darmstadt on the 21st October (this collection alone occupied more than eighty boxes of different sizes); and leaving these for despatch, we proceeded at once to Geneva, where we devoted some time to the valuable collections of Professor Pritet and others. Thence we hurried to Turin, where, with the aid of Professor Sismonda, we went carefully over the noble series of fossils; thence to Milan, to compare the highly interesting originals of the labors of Stoppani and Meneghini; and thence to Bologna, where the earnest aid of Professor Capellini enabled us to examine the fine series of vertebrated fossils there preserved. We were then obliged to hurry on to Brindisi to catch the steamer for India.

In the foregoing brief summary of our movements, several places have been omitted, as they only occupied us for a few hours, devoting

the morning to a visit to the collections, and travelling on by night to some other place. It will suffice to say that upwards of fifty collections have been examined, special attention in all cases being devoted to such points as were of special interest in Indian geology.

From many of these places I obtained valuable donations; in some I took advantage of the friendly co-operation of the Professors to purchase several things much needed to supply deficiencies in our collections. None of these have as yet arrived, and a detailed list of them must, therefore, be deferred. Altogether more than 30 boxes (independently of the Klipstein collection) have been already despatched, and there are many more to follow.

I gave special attention to adding to, and completing, our most valuable and extensive series of meteorites, and I am happy to be able to report that I have returned with no less than 36 specimens, representing 33 different falls. These are not all new to our Indian collections, as we already had representatives of 10 out of this number, but I have been able in several to obtain better specimens than we previously had, while 22 or 23 are entirely new to our series. A few of these were purchased, but the majority were received as donations or in exchange. This addition again maintains the Calcutta series of aerolites in its position as the most numerous in existence.

I regret exceedingly that time did not admit of our visiting the collections at St. Petersburgh and Moscow, which have a special interest for Indian geologists from the geographical position of the localities whence many of them have been obtained; but it would have been impossible to have accomplished this, excepting by neglecting other places.

Without anticipating more detailed lists, I may note, as among the more important donations,—from Vienna, a valuable series of trachytic rocks from Hungary, and some good fossils from Munich, a most important series of careful casts from the originals of the Schlagentweit Himalayan collections as described by Professor Oppel; from Professor Hebert, Paris, an excellent series of Normandy fossils; from the Royal School of Mines, London, a good collection of carboniferous limestone fossils (nearly 400 specimens), also a good series of minerals; from David Forbes, Esquire, a number of rare minerals; from Dr. Gemitz, some beautiful Dyas fossils, &c., &c. Of all these, detailed lists will be prepared on their arrival. Several valuable donations of books have also been received.

There have thus been obtained (quite independently of any purchases) very large and valuable accessions to our collections, both of fossils, minerals, and rocks. Several of the standard and typical series and sections of Europe have been compared; and in addition to the immediate and present advantages, relationships of friendly intercourse, and of scientific exchange and co-operation, have been established with many new institutions and fellow-laborers in geology, which cannot fail to produce most important contributions in the future.

The result of all this careful comparison of standard European types has been highly satisfactory. Very much has been seen and learnt which could never have been acquired from descriptions alone; and while it will be necessary to make, in consequence, a few changes in the identifications of Indian fossils, by much the majority of the alterations will be in the European descriptions. The most satisfactory evidence of the general accuracy of almost all the conclusions we had previously arrived at has been obtained.

Seeing that these valuable results have involved no additional expenditure whatever, and have been obtained during a season when, owing to climatical causes, no field work is practicable in Bengal, I trust that His Excellency in Council will consider with me that they are most highly satisfactory.

I would bear the strongest testimony to the untiring zeal and devotion with which Dr. Stoliczka gave himself to the task before him, and to the liberality with which he never scrupled to incur expenditure in travelling constantly and rapidly in order to save time for other work,—expenditure which his limited pay certainly could not have sufficed to meet.

From A. P. HOWELL, ESQ., *Under Secretary to the Government of India* HOME DEPARTMENT, *to the Superintendent of the Geological Survey of India,—No.* 111, *dated 9th January* 1868.

I am directed to acknowledge the receipt of your letter No. 803 dated 11th ultimo, relative to the proceedings of Dr. Stoliczka and yourself in your recent examination of standard geological collections in Europe.

2. In reply, I am directed to state that the Governor General in Council has read your report with much interest, and I am to express to you His Excellency in Council's high appreciation of the zeal so successfully displayed by Dr. Stoliczka and yourself in obtaining specimens and acquiring information of great value to the Geological Survey of India.

Proceedings of the Government of India, in the Financial Department,—No. 254, *dated 15th January* 1868.

Read the following—

From the Right Hon'ble SIR STAFFORD H. NORTHCOTE, BART., *Secretary of State for India, to His Excellency the Right Hon'ble the Governor General of India in Council,—No.* 410, *dated 23rd November* 1867.

Letters from Dr. Oldham, dated 13th July, 19th September, and 8th October 1867.

Letters to Dr. Oldham, dated 5th and 26th September and 25th October 1867.

I forward herewith, for your information and guidance, copy of correspondence with Dr. T. Oldham, Superintendent of the Geological Survey of India, relative to the purchase and transmission to India of Professor Klipstein's collection of fossils and minerals.

From T. OLDHAM, ESQ., LL. D., *Superintendent of the Geological Survey of India, to the Under Secretary of State for India,—Dated London, 13th July* 1867.

I have the honor to solicit the favor of your submitting to the Right Hon'ble the Secretary of State for India in Council the following statement for orders.

It will be known to the Right Hon'ble the Secretary of State, that, accompanied by Dr. Ferdd. Stoliczka, Palæontologist to the Geological Survey of India under my charge, I have been authorised to come to Europe, during the recess season in India, for the purpose of comparison of such European collections as cannot be made available in India, but of which a careful study is essential to the proper understanding of Indian fossils and rocks. Such occasional visits must ever remain essential to the sound progress of geological knowledge in India, until we have been able to bring together in that country collections and libraries of reference sufficiently extensive for general use. The procuring, therefore, of such series has been one of the main objects of our research. We have already visited all the museums and geologists in Gratz, Vienna, Prague, Cracow, Breslau, Dresden, Leipzig, Halle, Berlin, Brunswick, Hanover, Gottingen, Giessen, Bonn, Aachen, Maestricht, &c. &c. We have invariably met with the most hearty and friendly aid from the many distinguished mineralogists and palæontologists we have met ; with all we have established relations of exchange and co-operation, which will in future years prove invaluable ; from several, I have already obtained donations of selected fossils of rarity and interest which it would have been impossible to have obtained in other ways, and of which the mere money value is very considerable.

Among other collections, we spent some time in the study of the very extensive and valuable collection of Professor Klipstein in Giessen. This series is of the highest interest, as containing the originals of many of Professor Kilpstein's valuable descriptive papers. It is the result of five and twenty years of continued labour ; it is very extensive and in good order.

Family reasons and pecuniary difficulties have induced Professor Klipstein to offer the whole of this extensive collection for sale in one lot. It contains briefly summarized the following series :—

VERTEBRATA.—Inclusive of the splendid head of the dinotherium, the originals of many other descriptions and a fine series of bones of birds, there are from—

	Specimens.
Tertiary deposits of North Germany	3,890
Older ditto ditto	150
Tertiary deposits of South Germany	1,610
Older ditto ditto	60
From other countries	516
Total ...	6,226
With about 400 casts of rare species not now procurable ...	400
	6,626

Making a total of more than 6,500 specimens of the vertebrate fossils alone.

MOLLUSCA.—Of this large order, the collection contains nearly 2,000 specimens; of these a summary is given in the margin. *Plants* fossil, a very fine series from the Wetteran, containing about 1,600 specimens.

MOLLUSCA.

Secondary Tertiary from Wurtemberg, Bavaria, Tyrol, &c. ...	2,680
Bohemian Cretaceous	300
Bohemian Silurian	150
Vienna Basin	900
Alps, Styria, Corinthia, &c. ...	2,500
Westphalia, &c., Devonian... ...	642
Westphalia Cretaceous, &c. ...	900
Middle Rhein Devonian	930
Hanover Cretaceous, &c.	350
Belgium Carboniferous	600
Aachen and Maestricht	250
N. France all formations not 37 ...	690
N. France Tertiary...	2,520
S. France older formations... ...	1,150
S. France Tertiary	1,200
Italy and Sicily	1,020
England, Sweden, Russia, America, &c., about	3,000

In addition to the fossil series, the collection contains—1st, a systematic geological series with 8 to 9,000 specimens; 2nd, a geographical collection with about 8,000 specimens from Hesse and North Germany, and about 4,000 from other countries, and of *minerals* a large suite, the exact number of which I did not ascertain, but which contains many excellent specimens, several of which are of varieties which, though not uncommon a few years since, cannot be obtained now.

The number of specimens alone exceeding 50,000, is, however, a very inadequate index to the value of the collection. Many of the species are very rare, several unique. The head of the dinotherium alone represents a money value of some hundreds of pounds, and in a similar way many others are of high value.

The chief value of the collection undoubtedly consists in the very extensive and varied series of the remains of vertebrate animals. These vertebrate remains are precisely those which can never be obtained in the ordinary way from mineral or fossil-dealers. They are rare in occurrence, and are immediately picked up by local collectors and others interested in such studies. So much so, that it may safely be asserted that a good collection of vertebrate fossils could not be made at once, *at any cost*, through the agency of ordinary dealers.

Such a series also is precisely that which is most needed in India. It is at present quite impossible to work out *in India* the wonderful series of fossils which occur within its limits. There exists no collection for comparison; and until such a series be formed, it will be essential, for any real and satisfactory progress in Indian geology, to send or bring specimens for comparison with European collections, while this can be done only at such cost of time and money, and at such chance of loss and injury that every one is anxious to avoid the risk.

Some collection of this kind is therefore absolutely essential for the progress of scientific enquiry in India; and I have no hesitation in saying that an opportunity of securing so good a series as the present, is not likely to recur. I have heard of no other collection of the same kind now in the market, nor of any other likely to be. I am also aware that if not quickly secured, the present collection will in all probability go to America at once.

For the entire series, Professor Klipstein asks the sum of Florins 35,000 or £3,500, this is to include packing. I should not wish to

entrust the packing of such a collection to any other supervision than our own, and I would therefore propose to reserve for packing, insurance, &c., the sum of £500.

I believe the collection is well worth this sum or even more. Indeed it is a series so entirely unlikely to be met with again that it is extremely difficult to fix the true limits of its value. I believe also that it is a collection admirably suited to the wants of India in this direction, and that the acquisition of it would give a stimulus to the study of Comparative Anatomy and Palæontology in that country, which would yield valuable results and tend perhaps more than any other single step to give a practical direction to the studies of the many able Native students of medicine and anatomy, who are now without any object or stimulus to prosecute these enquiries subsequently to their leaving college.

Another gain would be this, that from the extent of the collections, many typical duplicates could be supplied to local College Museums. As Superintendent of the Geological Survey, I have frequent applications for such specimens, which I always regret being unable to comply with.

Under these circumstances, I would solicit that the question may be brought before the Right Hon'ble the Secretary of State for India in Council, and that I may be favored with orders on the subject. It is desirable to be able to give a definite reply to Professor Klipstein at as early a date as possible. I would earnestly urge the propriety of securing this valuable collection for the Indian Museum Calcutta, and of seizing the opportunity of my being at hand with Dr. Stoliczka to have it safely packed and despatched. Should this recommendation be acceded to, I would ask authority to permit Professor Klipstein to draw one-half of the amount payable on his definitely agreeing to the terms, and the remaining half on the completion of the packing, &c. of the entire collection. And that I might myself be authorized to draw such sum not exceeding £500, as may be requisite to pay for packing cases, freight, &c., all such expenditure being supported by vouchers as usual.

I would again urgently solicit that the purchase of this valuable collection may be sanctioned, believing that it would tend most effectively to facilitate scientific enquiry in India.

From J. COSMO MELVILL, ESQ., *Under Secretary of State for India, to Superintendent of the Geological Survey of India,—Dated India Office, London, 5th September* 1867.

I am directed by the Secretary of State for India in Council to acknowledge the receipt of your letter of the 13th July last, and to acquaint you in reply that he is prepared to sanction the purchase of Professor Klipstein's collection of fossils at a cost not exceeding £3,000, if a further examination should confirm your opinion as to its value for scientific purposes in India, and if it should correspond with the description given of its condition and preservation. The Secretary of State in Council is also willing to authorize you to incur the expense

of £500 for packing the collection, &c., and requests that you will personally make such arrangements for the purpose as may secure the specimens from injury in transit.

With reference, however, to the more rare and unique specimens referred to in your letter, and especially to the fossil remains of the dinotherium, Sir Stafford Northcote is of opinion that it would not be desirable that such fossils, the scientific interest of which is principally associated with the Geology of Europe, should be lost to this country and to scientific men of the neighbouring continent; whilst therefore he is prepared to sanction the purchase of this collection, Sir Stafford Northcote requests that you will endeavor to arrange for the fitting disposal of specimens of the class above referred to by making them over to some of the principal institutions of this country for their proportionate value, or in exchange for such other specimens as you may consider would be of more service in promoting scientific research in India.

Sir Stafford Northcote desires me to suggest whether it might not be desirable that casts of the fossils thus disposed of, be prepared and sent to Calcutta with the rest of the collection.

From T. OLDHAM, ESQ., *Superintendent Geological Survey of India, to the Under Secretary of State for India,—Dated Darmstadt,* 19*th September* 1867.

I have the honor to report, for the information of the Right Hon'ble the Secretary of State for India in Council, that on the receipt of your letter dated 5th instant, I at once proceeded to Giessin, and commenced the detailed examination of Professor von Klipstein's collections. The very limited space at his disposal for the exhibition of the collections, the necessity for going over each portion in succession, and the fact that parts of the collection were here, in Darmstadt, as well as in Giessen, have rendered this comparison more tedious than I had hoped. With the zealous aid, however, of Dr. Stoliczka, Palæontologist to the Geological Survey of India, it has now been completed. In some respects I found the collection not of the value I had been led to suppose; in others my estimate was too low. I took the precaution, therefore, of getting Dr. Stoliczka to estimate the value of each portion without any communication with me. I did the same myself, and then taking our separate results and finding that the total value, which we had thus assigned, agreed so nearly that there was less than £100 difference between the two sums, I felt greater confidence in the correctness of the estimate.

I have, therefore, agreed to give to Professor von Klipstein for the entire series the sum of £2,400. This is £600 less than the amount sanctioned in your letter.

I have already made a commencement of the packing, which shall be carried out without any delay.

With reference to the second paragraph of your letter, I have to report that such specimens, as it may be desirable to make over to some of the principal institutions of England, shall be packed up first

and despatched at once to London. As soon as they shall have arrived there, I shall myself return and endeavour, to the best of my ability, to carry out Sir Stafford Northcote's wishes, so as to render them freely accessible to men of science.

I have now further to request the favor that authority may be given for the issue to me of two cheques of £1,200 each, to be handed to Professor Von Klipstein, on delivery of the collection, and of the sum of £500 to me, to provide for the effective packing and disposal of this series. Detailed vouchers shall be submitted in support of these charges on completion of the work.

From HERMAN MERIVALE, ESQ., *Under Secretary of State for India, to the Superintendent Geological Survey of India,—Dated India Office, London, 26th September* 1867.

I am directed by the Secretary of State for India in Council to acknowledge the receipt of your letter of the 19th instant, and to forward herewith two cheques in favor of Professor von Klipstein for £1,200 each, and one in favor of yourself for £500.

From T. OLDHAM, ESQ., *Superintendent of the Geological Survey of India, to the Under Secretary of State for India,—Dated London, 8th October* 1867.

In continuation of former correspondence on the subject of the purchase of Professor Von Klipstein's collections, I have now the honor to report that, in order to carry out the liberal views of the Right Hon'ble the Secretary of State for India, I have now brought to London the unique and most valuable specimens from that collection. These are the skull of the *dinotherium*, the head entire of the *doreatherium*, the lower jaw complete, and a separate rumus of the same of the *tapirris prescus*, all unique and classical specimens. These valuable fossils, I have now arranged with the keeper of the Palæontological Department of the British Museum; to hand over for deposit in the national collection, on satisfactory terms, which only await the final sanction of the Trustees. This will, I trust, be accorded within a very few days.

Considerable progress has been made in the packing of the remainder of the collections for transmission to India, and I can now speak more fully than before as to the extent of the series:—

1*st.*—The petrological and geological collection is really good and extensive. In conjunction with such specimens as we have already, this will enable me to put out in Calcutta a thoroughly useful and nearly perfect series, and one rarely equalled for either study or comparison.

2*nd.*—The mineralogical collection is also good so far as it goes. It has not, however, been added to of late years, and there are still many deficiencies which must be supplied before it can be said that we have an efficient mineralogical series in Calcutta.

3*rd.*—The fossil series is also good so far as it goes, but as in the mineralogical, so in this series, there are many gaps which must be filled in.

Seeing, then, that the collection, as a whole, has not altogether supplied the wants which, on a more cursory inspection, I had hoped it would meet, while at the same time, the cost has been reduced in similar proportion, I would express an anxious hope that I may be permitted to supply the deficiencies, by purchasing, wherever procurable, such wanting mineral species and such characteristic fossils. If authorized to do so now, while I should be personally able to select, I think the expenditure of £500 would meet these requirements, as far as it would be practicable to do so at the present time.

I may add that this sum, in addition to the amount already paid for the Klipstein collection, will not amount to the limit so liberally sanctioned by the Right Hon'ble the Secretary of State in Council.

From HERMAN MERIVALE, ESQ., *Under Secretary of State for India, to the Superintendent of the Geological Survey of India,—Dated India Office, London, 25th October* 1867.

I am directed by the Secretary of State for India in Council to acknowledge the receipt of your letter of the 8th instant, and to acquaint you in reply that Sir Stafford Northcote is not prepared to sanction the expenditure of a fixed sum for the purpose to which you refer; but that any specific recommendations which may from time to time be made by you for the purchase of specimens to supply deficiencies in the Klipstein collection of fossils and minerals, will receive due consideration at this Office.

ORDERED, that a copy of the above be forwarded to the Home Department for information.
